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THE FRITSCHE WHEEL DYNAMO.

THIS is a type of machine simultaneously evolved, says *Industries*, in France by M. Desrozier and in Germany by Herr Fritsche. As far as the principle is concerned, this was in the Elphinstone-Vincent dynamo, with a drum armature formed of a cylinder of insulating material, upon which were laid saddle-shaped rectangular wire coils, arranged to form a continuous winding all round the outer circumference of the drum. There were external and internal magnets, and the active wires of each coil were carried through the interpolar space, cutting the lines of force at right angles. Now, if we imagine one end of this armature enlarged and the other reduced, we obtain a truncated cone, and by continuing this process the cone will gradually become flatter and flatter, until it assumes the shape of a disk, while the set of internal and external magnets will have changed to a set of magnets arranged on either side of the disk. Thus out of the Elphinstone-Vincent we have evolved the well known Edison disk dynamo, which, however, has never come into practical use. M. Desrozier has taken up this type, and so far improved its details as to produce a good, serviceable machine, which is now being made by the Maison Breguet, Paris. A number of these machines are now at work, chiefly on board ship, and are giving satisfaction. One of the most current sizes has an output of 170 amperes at 105 volts pressure, the speed being 350 revolutions per minute. The electrical efficiency is given by the inventor as 83·2 per cent., and the weight 24 cwt., or almost exactly 1 cwt. per h. p. output.

In the Desrozier machine the armature conductors are of copper and arranged radially, the connection between their ends, both outside and inside, being made by segmental strips, and there is as usual a separate commutator. In all these details the Fritsche machine is different, though its principle is the same, viz., that of a disk armature without iron core revolving within a multipolar field, the lines of which are parallel to the spindle. In the Fritsche armature the conductors are of iron, to reduce the magnetic resistance of the interpolar space, and they are not placed radially, but with a certain rake, by which arrangement the segmental conductors are dispensed with. Finally, there is no separate commutator, the collection of current taking place at the outer periphery of the disk. In all these details, then, the machine is quite original, and different from other disk machines. The following description is based upon the German patent specification of this machine, supplemented by some notes which the inventor has been good enough to forward to us. The specification is a very interesting document, and thoroughly German in its leading idea. It is, in fact, a complete treatise of drum winding as applied to both a cylindrical surface and the surface of a disk. Starting with the ordinary method of drum winding introduced by Herr Hefner von Alteneck for two-pole machines, the inventor shows how from this can be evolved a modified winding by placing the conductors spirally so as to avoid the necessity of end connection, how the winding can be arranged so as to obtain only two circuits though there may be more than one pair of poles, and, finally, how the shape of the pole pieces can be altered to avoid the differential action to which the spiral arrangement of the conductors on the armature would otherwise give rise. The inventor next applies the same train of reasoning to disk machines, and arrives at the peculiar form of winding represented in Fig. 2. This illustration shows the arrangement of conductors in an eight-pole machine. The rake of the conductors is such that the angle inclosed between their inner and outer ends is one-eighth of a complete circle, or 45°. Thus two successive conductors come simultaneously under the influence of two neighboring poles, and the shape of the pole pieces is so chosen that no conductor is under the influence of two poles simultaneously. This is the reason for the peculiar form of the polar faces, N S, shown in the diagram. The conductors or bars are arranged in two planes, one close behind the other. One set of bars rake one way and the other the opposite way, their outer and inner ends being joined by plates placed parallel with the spindle, as shown more clearly in Fig. 3, where P are the magnet poles, D the commutator segments on the outer circumference, held apart by insulation, I; S is the shaft, and H a hub or wheel upon which the conductors are mounted. The current entering at the brush B^1 into the plate 11 (Fig. 2) divides between the bars, raking opposite ways, and flows successively through all the back and front bars in the direction indicated by the arrows, until it finally leaves the armature by the plate 1 and brush B^1. If the direction of the current entering the bar 11 and flowing downward in the figure be followed, it will be seen that the current successively passes through the bars 12, 18, and so on, until it reaches the set of bars marked 1, through the last of which it flows upward and out by B^2. Similarly the other half of the current entering the bar 11, and flowing to the left, traverses successively the bars 10, 9, and so on, until the last bar 1 is reached. There are 79 bars in each set, or 158 bars in all, and the total e.m.f. is the sum of the electromotive forces induced in the 79 bars which at any moment are in series. The bars are rigidly attached, and in metallic connection with the plates at their outer and inner ends, and are not insulated. The plates are grouped so as to form rings, as shown in Fig. 3, and are separated from each other by the insulation I. These rings are clamped with insulation inserted between metal rings bolted together. Fig. 1 (on page 11080) shows complete armature, and Fig. 4 complete 16-pole machine arranged for belt driving. The inventor claims that by the use of naked armature conductors, the possibility of the armature burning up under an excessive current has been entirely obviated; and that, in fact, this machine might be run with the armature conductors red hot without injuring the insulation. These machines are designed for very low speeds, and are specially intended for direct coupling with ordinary slow-speed steam engines. The following table gives some particulars of the current sizes, all intended to give a pressure of 110 volts:

Speed.	Current.	Output.	Armature Resistance.	Weight Cwt.	Weight per I. p.
180	50	5,500	—	38	3·8
160	85	9,400	0·060	42	3·3
150	130	14,300	0·040	56	3·9
140	200	22,000	0·025	76	3·6
140	330	36,300	0·0138	102	2·9
110	540	59,400	—	140	1·75

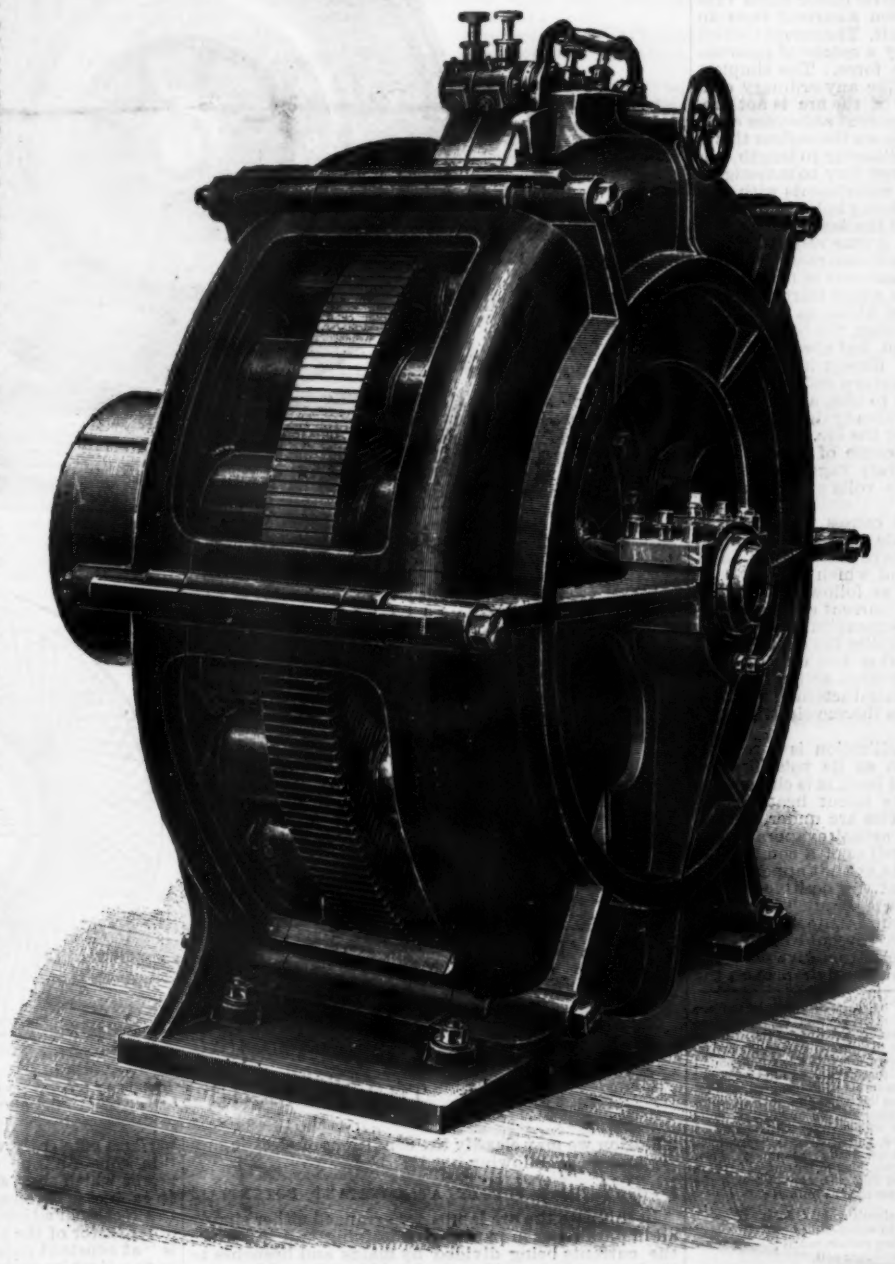

FIG. 4.—GENERAL VIEW OF COMPLETE 16-POLE MACHINE.

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ARC LAMPS AND THEIR MECHANISM.*

By Prof. SILVANUS P. THOMPSON, D.Sc., M.I.E.E.

AN arc lamp being an apparatus for transforming the electric energy supplied to it through the conducting wires into heat and light, it obviously cannot be expected to give a steady illumination unless it can be so arranged and operated that, in the first place, the rate at which it appropriates and transforms the electric energy is constant, and that, in the second place, the circumstances attending this transformation (in respect of the triple relation between the quantity of heat evolved, the degree of temperature, and the emissivity of the incandescent surface) also remain constant. The first of these two provisos relates to the operation of the system of lamps and dynamos (or other means of electric supply) acting conjointly; the second of them relates solely to the quality of the carbon pencils used as electrodes.

As the latter is a simple matter, it may be disposed of first. Suppose the pencils to be composed of a homogeneous carbon, the physical properties of which, such as a hardness, specific thermal capacity, conductivity for electricity, conductivity for heat, emissivity, etc., are constant; also that they are cylindrical and of given diameter. Then it follows that if energy is being expended at a uniform rate in heating the tips of a pencil, it will be maintained at a uniform temperature, and the amount of light emitted per square millimeter of the surface will be constant; and as the section is constant, the rate of consumption constant, and the pencil homogeneous, the form once acquired by the incandescent tip (whether positive crater or negative peak) will remain constant. It may be remarked, in passing, that the researches of Captain Abney have shown that the white light of the incandescent carbon surface of the crater at the positive pole of the arc is always of precisely the same composition in respect to the relative proportions of waves of different colors. This most important observation indicates beyond doubt that the temperature of the actual light-emitting surface is always the same. Indeed, this ought to be the case if the latent heat of vaporization of carbon be a positive quantity. When the surface attains this temperature, volatilization begins; and when so begun the temperature cannot rise further, any more than ice can be raised above its temperature of fusion. The limiting temperature of the voltaic arc is the temperature of volatilization of the material of the electrodes. This is, in itself, a reason why the introduction of all known foreign substances whatsoever into the carbon pencils of the arc is found to lower its intrinsic brilliancy; for all known elements have a lower te-

* A lecture recently delivered before the Society of Arts, London. From the *Journal* of the Society.

perature of volatilization, and all compounds are dissociated at arc temperatures.

If, then, we may assume homogeneity of the carbons to be used, the steadiness of the arc light will depend solely upon the maintenance of a steady rate of appropriating and transforming electric energy. How a want of homogeneity may be compensated for in the actual working of the lamp is a point reserved for consideration later.

The rate at which electric energy is appropriated from the wires, and transformed in the lamp into heat and light, always depends both upon the construction of the lamp and upon the conditions imposed upon the system of electric supply. This is a mere consequence of the fact, well known to every electric engineer, that the amount of electric energy per second appropriated by any electric device, motor, or accumulator, is itself the product of two quantities—the current and the pressure (or potential) at which the current is supplied. To put the matter in electrician's language, the number of *watts* of electric energy per second appropriated by the lamp* is equal to the number of *amperes* that flow through it multiplied by the number of *volts* that may be applied as a difference of potentials between its two terminals. To keep constant the *product* of the amperes and the volts is the practical problem which the mechanism of the arc lamp must be designed to solve.

A point of much theoretical interest, and in reality of great practical importance, is the fact, long disputed, now established beyond question, that the arc itself does not act simply as an added resistance in the path of the current, but exercises also a counter electromotive force, and tends to set up an opposing current. The apparent resistance of the arc resembles that of an electrolytic cell, or that of an electric motor when running, or that of a thermopile when a current from an external source is passed through it. The current which flows through the arc arouses, by a species of polarization, an opposing electromotive force. The simplest fact in proof of this is that, unlike any ordinary conductor, the apparent resistance of the arc is not proportional to its length. The apparent resistance of an arc two millimeters in length between the carbon tips is not double that of an arc one millimeter in length, nor anything near double. The fairest way to investigate the matter is to make a series of experiments with arcs of different lengths, the current being independently so regulated as to be maintained of the same strength in each case. There appears to be a true resistance proportional to the length, and a back electromotive force which in steady arcs, and with currents of from seven to fifteen amperes, appears to be about thirty-eight to thirty-nine volts. When the arc hisses, as often happens if the length of it be very short, the back electromotive force fluctuates very much, but always drops to something under twenty volts. Except in the case of constant-current circuits, this causes a sudden increase of current when the lamp begins to hiss, and it may be noticed that the light, though unsteady during hissing, is brighter at the negative pole of the arc.

Hitherto all guesses as to the cause of this counter electromotive force have been very vague, not to say wild. To account for thirty-nine volts of polarization on any hypothesis that it is due to electrolytic or thermo-electric action, is to suggest causes which are, to say the least, wholly inadequate. The explanation which for the past two years I have been in the habit of suggesting to my students, and which has not been otherwise published hitherto, is as follows: Every reversible phenomenon which the current can itself produce, and which requires an expenditure of energy for its production, necessarily implies the exhibition of a counter-electromotive force. One has only to look at the cases of the reversible chemical action in a cell, of the reversible magneto-mechanical action of a motor, the reversible heating effects of a thermo-electric junction, to comprehend this.

Now the phenomenon of volatilization is a reversible one: give to the solid carbon at its volatilization temperature the necessary latent heat, it is changed to vapor; take from the vapor its latent heat, it condenses back to solid carbon. The arc under normal circumstances is the seat of an actual evaporation of carbon at the positive pole, as well as of a combustion at both poles. So far as any data exist, it appears that the excess of carbon consumed at the positive pole by an ordinary continuous current is about 0·5 gramme per ampere hour. If we knew the latent heat of volatilization of carbon per gramme, we could calculate *a priori* the necessary minimum electromotive force at the positive pole, which would obviously represent the counter electromotive force so far as it is situated at that point.

With long arcs the excess of consumption of the positive pencil over that of the negative is both less and more regular than that which occurs with short arcs. With short arcs three other phenomena occur which are important in this connection. First, the short arc is liable to whistle or hiss, giving evidence of instability; secondly, it frequently gives rise to "mushrooms," or irregular growths of carbon upon the apex of the negative pencil; thirdly, when it hisses the counter electromotive force becomes very unsteady, but appears to have an average value about that of the steady long arc. It is worth while to throw out the suggestion that the condensation of carbon at the negative pole, in the short arc, is accountable for the change in electromotive force, and for the instability which manifests itself by the hissing sound.

Passing from these conjectures to the construction of lamps for the production of light by the arc, we are now prepared to lay down the points which must be provided for in every arc lamp. It must be emphatically pointed out at the outset that, as the performance of a lamp depends upon the conditions under which it is supplied with electric energy by the circuit, the design of the lamp necessarily also depends on those conditions. In the present state of the art of electric distribution we may classify the conditions of electric supply under the following heads:

I.—CONTINUOUS SUPPLY AT CONSTANT POTENTIAL.

In this case the arc lamps are arranged either simply all in parallel or in parallels containing two in series; the currents being divided by mains and branches to the lamps. At least 55 volts should be allowed between the mains for single arcs. Practice shows that arc lamps in parallel burn more steadily if a resistance wire of 0·25 to 1·0 ohm be included in the lamp circuit. Taking the back electromotive force of a steady arc at 39 volts, it is obvious that the excess of the volts at the mains over this represents the volts used in driving the current through the actual resistance in the main circuit of the lamp. This resistance consists of four parts—the true resistance of the arc itself, which may vary from $\frac{1}{10}$ to $\frac{1}{4}$ ohm; the resistance of the carbon pencils, which averages about 0·15 ohm per foot for plain carbons; the resistance of the main circuit coils, which varies in different lamps from 0·05 to 0·2 ohm; and the resistance of the wire introduced for steadying the lamp. In a ten ampere lamp, working at 55 volts at the mains, 16 volts remain, after deducting 39 for the back electromotive force, and these 16 are approximately distributed as follows: 2 volts in the arc itself, 3 volts in the carbons (say 2 feet long in the total), 1 volt in the main coil, and 10 volts in the steadying resistance.

II.—CONTINUOUS SUPPLY WITH CONSTANT CURRENT.

In this case the arc lamps are arranged in series, the whole of the current going from one lamp to the next, and returning to the dynamo after having traversed successively all the lamps. This is, *par excellence*, the arc light system of distribution, the parallel system at constant potential requiring heavier mains. As the lamps arranged in series tend to steady one another, it is not necessary to allow more than 45 to 50 volts per lamp, including the ordinary lengths of cable from lamp to lamp. From 5 to 10 amperes is the usual current for arc lamps in series.

III.—ALTERNATING SUPPLY AT CONSTANT POTENTIAL.

In this case also, the lamps are usually arranged as in the first case, the only difference being in certain structural details, such as lamination of iron cores.

IV.—ALTERNATING SUPPLY WITH CONSTANT CURRENT.

This case can hardly be said to be practical, though alternate current dynamos, capable of supplying 6 or 8 lamps in series, have been constructed in past years.

The supply systems, whether continuous or alternating, must be assumed, for the purpose of this paper, to perform efficiently what they profess, namely, to maintain constant one of the two factors of the electric power which they supply to the distributing system. In each case it remains for the mechanism of the lamp to effect such adjustment as will maintain constant the other factor of the product. If the condition of supply is "at constant potential," then it is for the lamp itself so to adjust its carbons as to keep the current through the arc constant. If the condition of supply is "with constant current," then the lamp must adjust its carbons to maintain between them the requisite potential. Hence the differences which are necessary in construction between those lamps which are to work "at constant potential" (in parallel) and those which are to work with constant current (in series). These differences, as will now be shown, chiefly affect the "feeding" mechanisms of the lamp.

In discussing the necessary mechanisms of arc lamps, no further reference will be made to lamps of the Jablochkoff candle type, nor to those with abutment blocks of marble ("Sun" lamp, etc.), nor to the so-called incandescence arc ("Semi-incandescent") lamps, nor to those with curved carbons (Heinrich's type), nor yet to those horizontal carbons (De Mersanne's, Soligac's, etc.).

NECESSARY MECHANISM OF ARC LAMPS.

[A.] *Driving Power.*—In every lamp some means or mechanism is required to propel the carbons toward

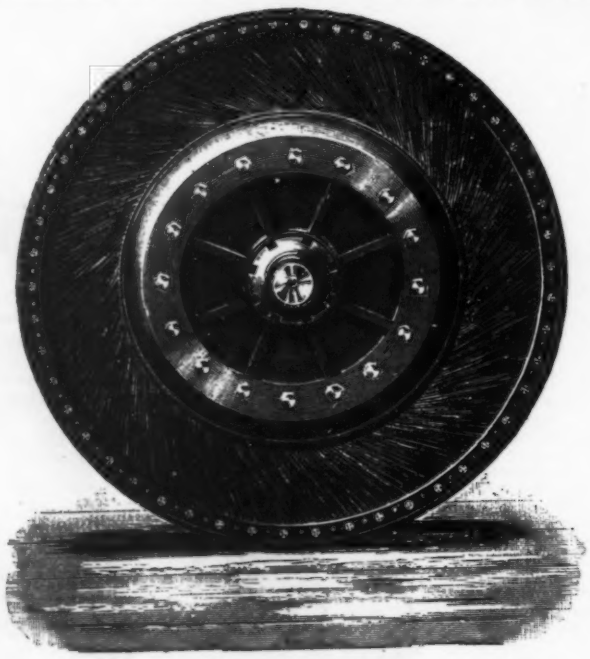

FIG. 1.

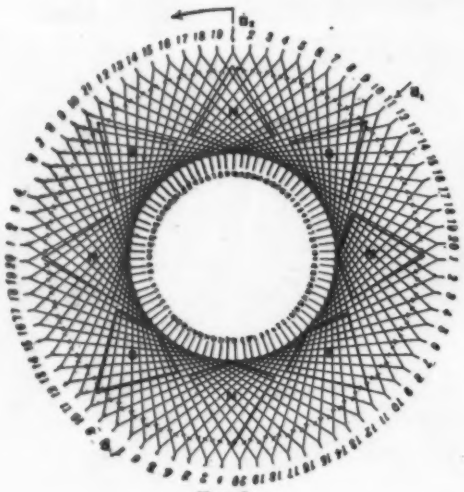

FIG. 2.

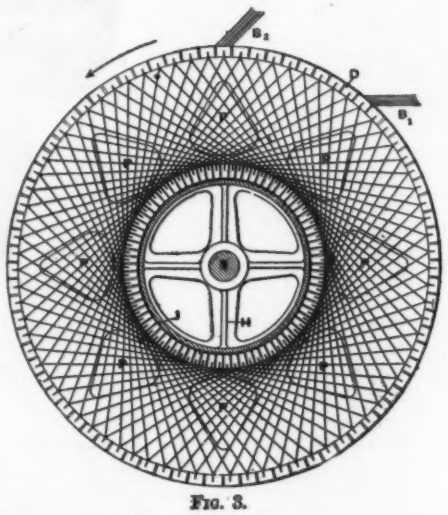

FIG. 3.

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* Strictly speaking, the actual number of *watts* utilized in the arc is somewhat less than the whole number received from the supply, as a portion of the energy is expended in passing the current through the regulating coils, and another portion is lost in consequence of the resistance offered by the pencils of carbon themselves, and is merely expended in warming them. We may calculate the former loss as follows: Let E represent the whole number of volts from terminal to terminal, and let *i* represent the whole current supplied, then the whole number of watts supplied is E*i*. Let the *ohms* of resistance of the regulating coils in the main circuit be called *a*, and that of the shunt coils be called *b*, that of the carbon pencils themselves *c*, and that of the resistance coils sometimes used in the main circuit to steady the arc, *f*. Also, in the case where the lamp has a shunt circuit, let the portion of *i* which passes through the carbons be called i_1, and that which goes through the shunt, i_2; so that $i_1 + i_2 = i$. The losses are then as follows:

ai_1^2 = watts lost in main circuit coil;
$bi_2^2 = E^2 \div b$ = watts lost in shunt coil;
ci_1^2 = watts lost in warming carbon pencil;
fi_1^2 = watts lost in the resistance coil.

The resistance of carbon pencils is usually small, and may be materially reduced by a thin coating of copper. The carbons used in commerce (11 to 15 millimeters in diameter) vary from about 0·15 to 0·2 ohm per foot, if plain, and from 0·001 to 0·09 if coppered. Cored carbons have a higher resistance than uncored. Carbons cut from solid gas coke have from five to twenty times as much resistance as those made by the usual modern processes. When lamps are run in series, the resistance offered by the pencils is of more importance; for example, a set of fifty lamps newly trimmed with long carbons may offer 25 ohms more resistance than when all the carbons have burned down short. The resistance, *a*, of the regulating coils that are in the main circuit differs in different lamps, but may be taken at from 0·05 to 0·2 ohm. The resistance, *b*, of the shunt coils is seldom less than 200 ohms, and may be as much as from 400 to 500 ohms. Of the volts, E, applied to the lamp only a part is utilized, the lost volts being accounted for by the resistances in the path of the current. If these are deducted from the applied electromotive force, there will remain a certain number of volts, which we may call *e*, which are available as a useful difference of potential at the arc itself. To measure *e* directly, one has only to apply a voltmeter, making the contacts of its two leading wires to the two carbons at points respectively just above and just below the incandescent tips. The watts actually utilized in the arc are then calculated as the product ei_1. As shown above, *e* is less than E, and, indeed, may be considerably less, the lost volts depending upon the resistances introduced and on the current flowing through them. If E is constant, *e* will not necessarily be so, but will be very nearly if *i* is also constant. Also i_1 is less than *i* in all lamps that have a shunt-regulating coil, but is not usually more than from 3 to 5 per cent. less than *i*, so that in the cases where *i* is kept constant, i_1 will be nearly so also.

one another as they burn away, gravity being by far the most common agency for doing this.

[B.] *Striking Mechanism.*—In every arc lamp it is requisite to provide a mechanism for bringing the tips of the carbon pencils into contact, and then parting them asunder to the requisite distance across which the arc or flame plays. If, as in most lamps, the carbons are in contact when the lamp is out of action, then a mechanism is required simply to part them as soon as the current is turned on. The operation of producing the arc by parting the carbons is known as "striking" the arc. The mechanism must be automatic, so as to come into action not only when the current is first turned on, but at any subsequent time if from any cause the arc fails. An adjustment, *b*, of the striking mechanism is also usually added to permit of regulation in the length of the stroke or initial distance between the poles.

[C.] *Feeding Mechanism.*—As the carbons burn away, one or both of them must be propelled forward to maintain the arc at its proper size. This action is called "feeding" the arc. This action ought to take place by small and imperceptible amounts, and as the rate of consumption of the carbons is continually varying, even with carbons of the best modern manufacture, the lamp must itself regulate the rate at which the pencils are propelled forward in automatic correspondence with the consumption for the time being. Further, since the presence of soft and more readily volatilized portions in the pencils seems to be unavoidable, provision ought to be made so that, whenever the pencil burns down to such a portion, causing a sudden increase in the volume of the flame or arc—technically called a "blower"—the mechanism of the lamp ought at once automatically to draw apart the pencils to a slightly greater distance. A lamp which has a *retractile* motion in either its feeding or its striking mechanism is superior to one that has not, as it can be used with cheaper and less pure brands of carbons. An adjustment, *c*, for regulating the frequency or range of the feeding movements is usual.

[D.] *Replacement Mechanism.*—When the pair of carbon pencils has burned away, the lamp trimmer has to replace the stumps by a new pair of long carbons. In order to admit these, the carbon holders must be pushed apart to their widest extent. Special mechanical devices for allowing this motion to occur have to be provided in some forms of lamp, while other forms need no special device.

[E.] *Moderating Mechanism.*—To prevent the carbon from making too sudden motions, it is usual to add a moderating device, such as a dash-pot, or, in the case of those lamps in which there is a train of wheels, a fan or a governor.

So far, the devices enumerated have been such as are common to all classes of lamps. Those which follow are only required in particular types of lamp.

[F.] *Focusing Mechanism.*—In all those cases where it is desired that the luminous points should occupy a fixed position in space, some additional mechanism is necessary to make the arc lamp keep its focus. In lamps designed for the mere lighting of area, this is not important, and in the vast majority of these the upper carbon descends while the lower carbon (the negative) is fixed: the luminous point slowly shifting downward as the carbons consume. All devices for causing the carbons to move forward at such relative rates as to keep an approximately fixed position for the arc will be discussed, together with their methods of adjustment, *f*, under the head of focusing mechanism.

[G.] *Change-over Mechanism.*—Lamps that must run for many hours continuously must be supplied with two pairs of pencils, because it is neither practicable nor advisable to use pencils of extreme length. In the double lamps it is appropriate to provide such arrangements as shall cause one pair of pencils to come into operation first, and, when these are consumed away, shall change-over the action, either by electrical or by mechanical devices, so that the second pair of pencils shall come into operation.

[H.] *Cut-out Mechanism.*—Lamps intended for series working must be provided with some contrivance to prevent the extinction of the whole series when from any cause there is a failure of the light in any one lamp. The usual device is a sort of automatic relay arranged in connection with each lamp, to come into operation in the event of its failure, the operation of the device being (1) to cut the faulty lamp out of circuit by simply short-circuiting it, or (2) to substitute for it a wire of suitable resistance, or (3) to replace it by an auxiliary lamp. The device for performing either of the two former operations is technically known as a "cut-out."

SUPPLEMENTARY CONTRIVANCES.

In addition to the eight distinct species of contrivances above enumerated, there are numerous details which might be further classified; such, for example, as devices for *clamping* the carbon pencils to their respective holders in true allignment; devices for raising and lowering the lamps. For these, however, there is no space. Neither is it possible to enumerate the devices which have been suggested [Staite, Siemens, Brockie, Andrews, Crompton, Swinburne, and others] for *compensating*, in lamps whose action depends on the weight of the descending carbon pencil and its holder, for the diminution of pull as the pencil is consumed.

SCHEDULE OF MECHANISMS.

A schedule embracing the eight heads above enumerated, if supplemented by statements of the gauges and resistances of the wires used in the windings of the coils, affords a systematic and very convenient method of tabulating the facts concerning the construction of any arc lamp. An example of such schedule, filled up with the data of one arc lamp of recent pattern, is given at the end of this paper.

ELECTROMAGNETS FOR ARC LAMPS.

As the electromagnet plays so essential a part in the striking, feeding, and cut-out mechanisms of lamps, a short digression upon the particular forms of electromagnets appropriate to arc lamps is not out of place. The ordinary treatises on electricity have little to tell about the special properties of different forms of electromagnet; indeed, this all-important organ in modern electrical engineering has received very inadequate attention from writers on electricity. It is a familiar fact that the attraction of a horseshoe-shaped magnet, whether of steel or iron, varies very greatly with the position of the iron armature, being great at small distances, but very rapidly falling away as the intervening space is increased. To devise a form of electromagnet whose attractive power shall be exerted over a fairly long range was at one time one of the practical problems of electricians, and it has been solved in various ways. The attraction which a solenoid, or tubular coil, exerts, when traversed by a current, upon an iron core introduced within its aperture, is not, in any position of the core, nearly as great as that exercised by an electromagnet of horseshoe type, constructed of equal amounts of metal, and energized by an equal current. On the other hand, the feebler pull of the solenoid upon its core is exerted through a very extended range. And by making the core of conical form, or by winding the coils of the solenoid in a conical fashion, it is possible still more completely to equalize the pull over a long range. Solenoids with cores are used in several well-known types of lamps in which a long travel is required. On the other hand, since the operation of striking the arc requires a short motion not exceeding one-twelfth of an inch, or two millimeters, in all those types of lamp in which a special electromagnet is used simply to strike the arc, a form of electromagnet is required which will exert a powerful pull over a short range. Further, for working certain clutch mechanisms and the like, it is desirable that a form of electromagnet should be found which, while having a travel of say one inch, should exert throughout the whole of that range a fairly strong pull, increasing of course toward the end. Experiments show that the special forms of electromagnet may be tabulated as follows:

(*a*) *Short-range Magnets.*—1. Horseshoe form, if constructed with short, thick cores, thick yoke, and thick armature, giving compact magnetic circuit.

2. "Pot magnet," straight core with external tubular envelope, connected by iron at bottom. Armature, a stout iron disk or lid.

(*b*) *Moderate-range Magnets.*—1. Horseshoe form with long, thin cores and armature, giving a non-compact circuit.

2. Solenoid having a short fixed core extending part of the way down, and a second movable core to be attracted in as plunger. The name "stopped solenoid" is suggested as appropriate for this form.

3. Two such as last, having a yoke connecting the two fixed cores, and a second yoke connecting movable cores.

4. Stopped solenoid with plunger attached to an outer mantle [Kennedy's lamp, Fig. 10].

5. Electromagnet with conical poles protruding through hollow in armature [Thomson-Houston lamps, Figs. 14 and 25].

6. Electromagnets with oblique approach of armature. [Serrin's, Fig. 5; De Puydt's, Fig. 23; and many other lamps].

(*c*) *Long-range Magnets.*—1. Solenoid, cylindrical, with longer cylindrical core. Attraction greatest when entrant end of core just reaches the further side.

2. Solenoid, cylindrical, with long coned core entering with the point foremost.

3. Solenoid, conical, with long cylindrical core entering the thicker end of solenoid.

4. Special device for travel of unlimited length. A solenoid constructed in sections, which are switched into circuit progressively ahead of the core as the core travels down* [Thomas, 578[83]; Lindemann, 16,376[87]].

It must be borne in mind that the range of an electromagnet depends on the relative dispositions of the iron parts of the magnetic circuit and of the magnetizing copper parts, and in no way upon the question whether the coil consists of a few turns of thick wire or of many turns of thin wire.

EQUALIZERS.

In sundry forms of lamp special mechanical devices have been introduced for the purpose of equalizing, throughout a given range of motion, the otherwise very unequal pull of the electromagnet upon its armature. Set-up springs with adjustable stops have been used for this purpose. A more satisfactory *equalizer* (*repartiteur*) is the device suggested by the famous conjuror, Robert Houdin, which is depicted in Fig. 1. Here the

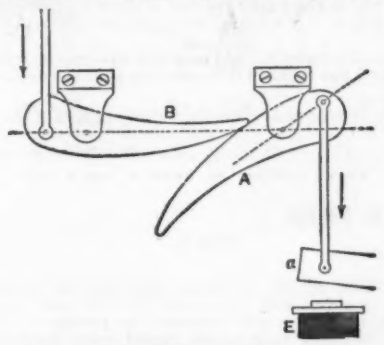


FIG. 1.—HOUDIN'S EQUALIZER.

attraction of the electromagnet, E, for its armature, *a*, is transmitted through a system of two curved levers, A and B, which rock on one another at a point of mutual contact which varies the "mechanical advantage" of the system, and partially or wholly, according to the curvature, compensates for the great increase of force as the distance of the armature diminishes.

The form of the equalizer of Foucault, as used in the Foucault-Duboscq lamp, is depicted in Fig. 2. Here the armature, *a*, which is stiffly pivoted eccentrically to allow of adjustment, is attached to a lever, A, whose fulcrum is at F, and the opposing force of a spring, *s* (itself adjustable by the screw, *r*), is applied through the curved rocking lever, B. The vertical arm attached above F carries the detent, D. Equalizers depending on use of a rocking lever are to be found in several lamps [Serrin's lamp; also Mackenzie, 95[82], and Common, 626[87]].

Returning from this digression, we have now to go separately over the eight items of the schedule, and point out how the various necessities have been met by the ingenuity of various inventors. As it is impossible to mention all instances of carrying out a principle, reference is made only to a few cases, preferably to the best known lamps.

* Figures in square brackets relate to patent specification or date.

[A.] DRIVING POWER.

The following devices have been used:

1. *Gravity.*—Descent by its own weight of upper carbon holder [innumerable lamps]; ditto, aided by weights specially attached [Gulcher, 1,915[87]]; ditto, partially opposed by coiled spring to compensate for consumption [Siemens, 366[86]]; clockwork driven by weights [Staite, 11,783[47]]; lower carbon floated upward in mercury [Tommasi, 4,405[87]].

2. *Coiled Spring.*—Drives by pinion and rack, or pulley and cord [Foucault, 1,848; Staite, 11,449[46]]. Differential action of two coiled springs [Foucault-Duboscq lamp].

3. *Electromagnetic Motor.*—(*a*) Suction of core by solenoid; (*b*) electric motor rotates and drives carbon rod [Bousfield, 523[79]; Breguet, etc.]; (*c*) electromagnetic vibrator drives carbon rod [Clark-Bowman, 1,182[48]; Newton, 1,623[82]; Pieper, 4,133[84]; Holmes, 769[84]].

4. *Hot Air.*—Heated air rising from lamp drives fan to propel carbons [Varley, 5,656[81]].

[B.] STRIKING MECHANISM.

To strike the arc requires mechanical devices; but as these are to be actuated by the current itself, it is appropriate first to consider what electric mechanism is necessary or sufficient to actuate the movement. Assuming that the carbons are initially in contact when there is no current, the current when turned on must

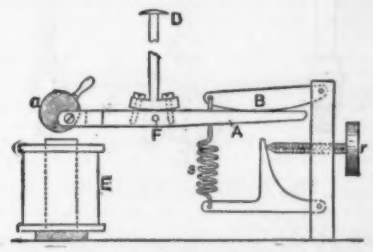


FIG. 2.—FOUCAULT'S EQUALIZER.

part them; the appropriate device is therefore an electromagnet (or solenoid with its core in lieu thereof), having its coils in the main circuit of the lamp. [Foucault, 1847; Staite, 11,783[47], and in the vast majority of modern lamps.] If, however, the carbons are initially apart, the lamp must itself bring them together; and the appropriate device to actuate this movement will be an electromagnet (or solenoid) connected as a shunt, and therefore having fine wire coils of high resistance. Such an arrangement will bring the carbons together by the action of the by-pass current, and as this falls almost to zero on the contact of the carbons, they will be at once parted (and the arc struck) by the opposing force; this force may be that of gravity [Lontin, 1875] or a spring [Lever, 2,092[82]; Thomson-Rice, Fig. 39]. The disadvantage of this second method is that the initial resistance of the whole series of lamps standing with their carbons parted is enormous unless there is a cut-out circuit. Another method of striking the arc is by cutting out a main circuit electromagnet [Crompton, 346[82]; Bright, 377[87]].

The modes of parting the carbons are various:

1. Drawing both carbons asunder by gearing [Foucault-Duboscq lamp].

2. Drawing down the lower carbon by electromagnet placed in base [Staite, 11,783[47]; Serrin, Breguet, Sellon, Newton, Pieper, Holmes, etc.], or by electromagnet situated at top [Crompton "E," 1881; Gramme; Silvertown Co.; Fein, 1888].

3. Lifting upper carbon rod [Roberts, 14,198[83]; Slater and Watson, 212[83]; and the vast majority of modern lamps, Brush, Siemens, Crompton, Pilsen, Brockie-Pell, Thomson-Houston, etc.], or lifting upper carbon by an electromagnet situated in the carbon rod [Abdank, 1884]; or by lifting bodily the upper carbon and the whole of the feeding train [Crompton, 346[82]; Fyfe and Main, 3,821[81]; Berjot, Wood, Hochhausen, Maxim, 1,649[80]; Gumpel, 253[81], etc.]; or by rocking the feeding train around a center [Brockie, 2,370[82]; De Puydt, Fig. 23].

The mechanical devices for performing these various actions are numerous, and their action is complicated by the endeavor of many inventors to cause the same mechanism which initially strikes the arc also subserve the purpose of feeding the carbons. In some lamps, however, these functions are kept separate. An example of a lamp in which the striking and feeding mechanisms are kept separate is afforded by the Breguet lamp (Fig. 3), in which an electromagnet draws down the lower carbon holder to strike the arc, while the feeding is accomplished in the subsequent gradual descent of the upper carbon. In the lamps of Newton, Sellon, and Holmes, there is used the special form of short range electromagnet, *a* (2 in the list), having a central core and external tube of iron. There is a very numerous class of lamps in which a clutch is caused to grip the upper carbon holder, and then to raise it so as to strike the arc; the same clutch being subsequently so operated as to permit the carbon holder—a smooth rod—to slide down by degrees as required, to feed the carbon pencil forward. Such devices are best considered under the heading of feeding mechanisms.

The adjustments of the striking mechanism may be of two kinds: (1) adjustments of range, such as limiting stops and set screws; (2) adjustments of force, such as the regulable spring shown in Fig. 1 at the bottom.

The main circuit electromagnets, and solenoids, used for striking the arc, are wound with a wire of large enough section to carry the required current without undue heating, and are of small resistance. The weight of copper wire employed varies from one to four pounds; and the resistance varies from 0·05 to 0·2 ohm.

[C.] FEEDING MECHANISM.

The electric devices here differ in the case of lamps for parallel working and lamps for series working.

(*i.*) *For Lamps in Parallel.*—Assuming that the supply mains are kept at constant potential, then the lamp mechanism must be responsible for keeping the other factor of the electric power, namely, the current through the lamp, at a constant value. That is to say, whenever, by reason of the burning away of the carbon points, the arc grows long, offering more resistance, and, therefore, reducing the current below its normal value, the lamp must automatically feed the pencils forward, and so readjust the current. It is obvious that, in this case, the weakening of the current through the lamp may be caused to bring the feeding mechanism into operation by the use of an electro-magnet (or solenoid) in the main circuit. For if the

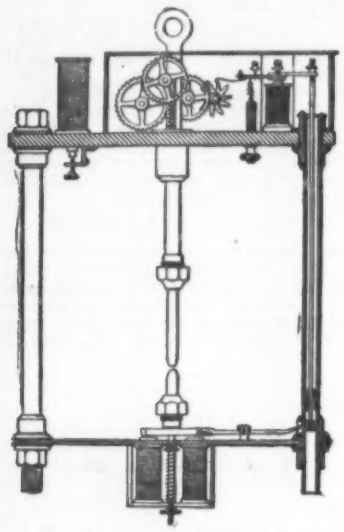


FIG. 3.—BREGUET LAMP.

armature of this electromagnet be held back by a spring or weight which only just counterbalances the pull of the magnet when the current is normal, the weakening the current will at once cause a movement of the armature which may be utilized to relax a clutch, lift a detent, or release an escapement. And it is also obvious that in this case it is possible to arrange the same electromagnet which strikes the arc to actuate the feed. Examples of the use of a single main circuit electromagnet to actuate both the striking and the feeding mechanisms are to be found in the Serrin lamp, in the Gulcher lamp, and in the Brush lamp as arranged for parallel working.

(*ii.*) *For Lamps in Series.*—Assuming that the dynamo is doing its duty, and keeping the current constant, then in this case the lamp mechanism must be responsible solely for keeping constant the potential between the terminals. Whenever by reason of the burning away of the carbons, the arc lengthens and offers more resistance, if the same current is still supplied to it and forced through this greater resistance, it will burn more brightly, and the difference of potentials between the terminals of the lamp will rise above its normal value. The lamp must then automatically bring its carbons nearer, and readjust the potentials to the proper number of volts. It is obvious that the appropriate device to actuate the feeding mechanism must, in this case, be something that can play the part of a voltmeter, and will actuate the mechanism when the volts rise above their normal value. Practical voltmeters are of two kinds: (*i*) those which depend on the magnetic effects of the current that will flow through a wire of high resistance placed as a shunt across the two points between which the differences of potential exist, and (*ii*) those which depend on the heating effects of the current in such a wire. Either of these effects may be used to control the feeding mechanism of arc lamps; that is to say, the feed must be controlled by a shunt circuit, which will actuate the mechanism as soon as the potential rises above its normal value. The usual device is an elecromagnet (or solenoid) of fine wire and of high resistance (from 200 to 400 ohms), the armature of which is counterbalanced by the force of a spring, or by gravity, or by an opposing main circuit electromagnet (or solenoid). An alternative device, not, however, in general use, is a long thin platinum wire, which when heated by a current above the normal value will expand and actuate the feed. Thermal expansion has been attempted as a method of regulation by several inventors. [Lontin, 2,074[77]; Siemens, 2,281[78] and 2,110[79]; Munro, 1,636[85]; Edison, 2,072[88]; Pollak, 1888, etc.]

In the following table are comprised the several electrical arrangements for controlling the feeding mechanism:

(*i.*) *Constant Potential Lamps (for Parallel Working).*

(*a.*) Series electromagnet, same as used for striking.
[Serrin; Gulcher; Brush; Crompton, etc.]

(*b.*) Series electromagnet, separate from the striking electromagnet.
[Fontaine.]

(*c.*) Differential arrangement. Series winding partly opposed in shunt winding, on separate cores or parts of mechanism.
[Lacassagne and Thiers, 2,456[86]; Siemens; Brockie-Pell.]

(*d.*) Ditto, but wound on same cores.

(*ii.*) *Constant Current Lamps (for Series Working).*

(*a.*) Shunt electromagnet alone, acting against gravity or spring.
[Lontin, 1877; Lever.]

(*b.*) Shunt electromagnet separate from the striking (series) electromagnet.
[Numerous lamps. Breguet (Fig. 3); Crompton "E," Sellon, Gramme, Pieper.]

(*c.*) Differential arrangement. Shunt winding pulling against series winding, on separate part of mechanism.
[Lacassagne and Thiers; Siemens "differential"; Pilsen; Crompton-Crabb "DD"; Thomson-Houston; Brockie-Pell; Kennedy.]

(*d.*) Differential winding.
[Numerous lamps. Brush, Weston, "Simplex."]

The typical arrangement of circuits for lamps that are to be run on a system of arc lighting in series is shown in a generalized diagram in Fig. 4. The striking coil is in the main circuit; the feeding coil is a shunt, which if wound on the same core as the series coil in any of the differential systems, must be so wound that the currents circulate in opposing senses. There is also added a cut-out circuit, having both a shunt coil and a small series coil; but these must be so wound as to help one another's magnetic power, and the small series coil must itself be a shunt to the main circuit of the lamp.

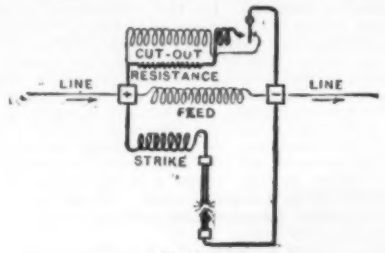


FIG. 4.

(*To be continued.*)

SIEMENS' RECORDING APPARATUS FOR COMPACT MORSE WRITING.

THE alphabet formed by the combination of two elementary signs, the "dot" and the "dash," which is used in Morse telegraph instruments of the recording type, is almost universally writen in a single longitudianal line on the paper strip.

This method of writing, however, possesses the great disadvantage that the diameter of the writing disk cannot be made very small, as it would not then be certain to dip into the ink contained in the trough. A disk of comparatively large diameter, although clean in its working, is unsuitable for producing a short and sharp sign on the paper strip, particularly when the strip is moving slowly, as the tangential contact between the writing disk and the paper produces an unnecessarily long sign with a large disk, and hence the tendency to "tailing" is increased. It is for these reasons that the "dots" of the Morse alphabet can in general practice only be produced as short dashes, so that, in order to prevent misapprehension, the "dashes" require to be made longer than would be necessary if distinct dots could be produced. The writing is thus spread over far more paper than is desirable, causing not only a waste of paper, but making the reading more difficult.

Various suggestions have from time to time been made with the object of remedying this defect, but owing either to complication in the methods of transmission or of reception, none of these proposals has been adopted to any considerable extent.

The "compact writing" has been designed to meet the demand for improvements in the old system of Morse writing. Its elementary signs consist of lines at right angles to the edge of the paper strip, and of equal width but of different length (measured in the direction in which the paper travels), a short or thin line representing a "dot," and a longer or thicker line a "dash."

Fig. 1 illustrates the old and new systems of writing, and shows the relative difference in space occupied by them. The length of paper used for the compact writing is about half that used for the old writing, while a more readable message is produced. The amount of paper strip to be stored away for possible future reference thus becomes considerably less—an administrative advantage not to be underrated when the present enormous increase in telegraphic communication is taken into account.

The inking arrangement by which these compact signs are produced consists, as shown in Figs. 2 and 3, of a marking roller, *e*, of small diameter and of a width equal to that of the marks to be produced, mounted with its axis at right angles to the edge of the paper strip, and rotated by its frictional contact with the inking disk, *f*. This inking disk is carried on a spindle, *c*, resting in a bearing on the end of the armature lever, *b*, and is geared with the clockwork of the instrument by which it is revolved. It is of slightly greater width than the marking roller, and has a finely grooved periphery for more effectually taking up the ink. *a* is an ordinary ink trough, and *g* is a pad of felt which dips into the ink and presses against the inking disk.

The marking roller, *e*, and the inking pad, *g*, are both attached to the armature lever by flexible arms, and the amount of their pressure upon the inking disk is regulated by small set screws. *d* is the ordinary train of wheels over which the paper passes.

When the instrument is at work the end of the armature lever carrying the marking roller, inking disk, and inking pad is moved upward by the action of the electro-magnet, the marking roller being thereby pressed against the paper, making a short or long mark, according to the duration of contact. The inking disk is rotated by the clockwork, and, being supplied with ink from the pad, carries it to the marking roller which it, at the same time, causes to revolve. In this manner the marking roller receives a very even, though ample, supply of ink, and a freshly inked surface is constantly presented to the paper, by which means, combined with the very small diameter of the roller, short, sharp, and distinct marks are produced.

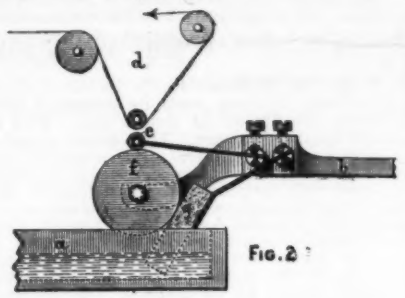


FIG. 2.

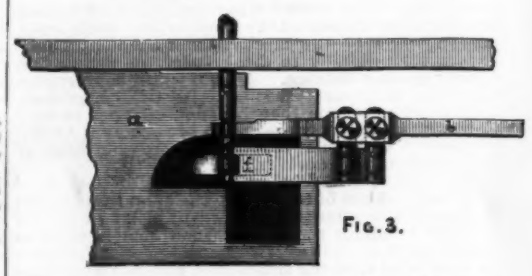


FIG. 3.

Experience has, it is said, shown that any disinclination that may be felt by telegraph operators to change the method of writing the Morse code is soon removed by the conviction that the new system offers considerable advantages to themselves, and that no difficulty whatever is experienced by the change from the old system to the new.—*The Electrical Review.*

INTERCALATING APPARATUS FOR PORTABLE INCANDESCENT LAMPS.

IN the annexed engravings we illustrate an improved switch or "intercalating apparatus" brought out by Messrs. Mix and Genest, of Berlin. The apparatus hitherto in use has the disadvantage that the switches must either be turned (screws or bayonets), or they cannot be turned at all, because the contact pieces are not centrally arranged. The idea of arranging the two contact pieces of the switch in the form of concentric tubes in and around the switch contributes to give the apparatus a solid construction. The contact pieces are connected by soldered copper wire with the segment-like binding screw in the handle. Fig. 1 shows the apparatus complete, while Fig. 2 shows the construction. The contact pieces of the connecting box are suitably arranged, and the two spring plates and the joint are

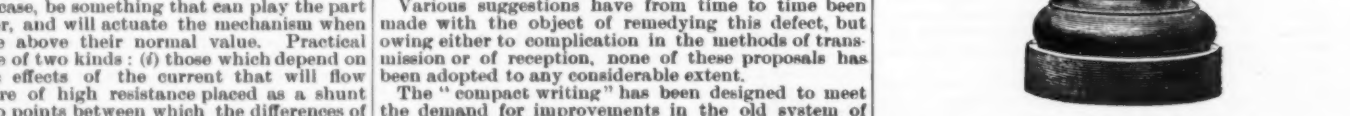


FIG. 1.

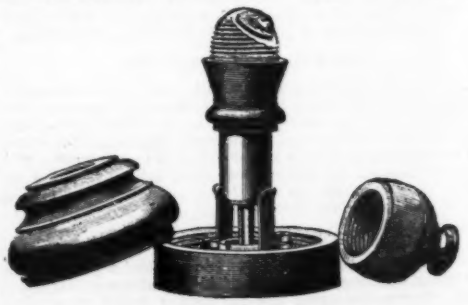


FIG 2.

stamped out of one piece and fastened by one binding screw. The spring pin being split with a conical top, when pressed into the interior contact tube completes the electric circuit with the ground plate fixed by the second binding screw. Besides its suitable and solid form, this apparatus has the advantage that the intercalation of portable glow lamps can be easily effected in the dark. No turning being necessary, the possibility of injuring the wire at the joining points is very remote. The apparatus can either be fixed on the wall or on a gas tube hanging from the ceiling.—*The Electrician.*

ACOUSTIC SIGNALING APPARATUS.

THE fog horn is an exceedingly valuable instrument for signaling at sea during night time or foggy weather, but its application has hitherto been confined to cases where either steam or compressed air was available. Moreover, a fog horn worked by steam power is a somewhat complicated piece of machinery, and the majority of vessels, especially if they be sailing ships, cannot afford to carry it. To meet such cases, Herr Pfannenstiel, mechanician, of Danzig, has constructed a siren

FIG. 1.—GENERAL VIEW.

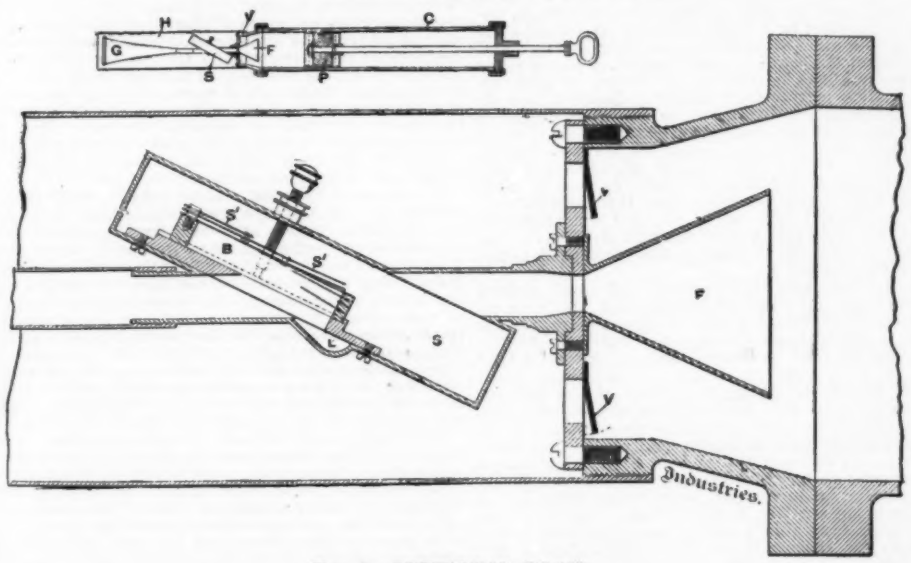


FIG. 2.—SECTIONAL PLAN.

IMPROVED SIGNALING APPARATUS.

worked by hand power, which we illustrate herewith. Hand fog horns have been made before, but in the apparatus we are about to describe, the inventor has introduced several important improvements, with a view to obtain a more shrill sound and to increase the carrying power of the instrument. We may here mention that this fog horn is shortly to be tried by the Trinity House authorities, while the trials made in Germany have been eminently satisfactory, the sound being carried to a distance of ten miles. Sound is produced by the vibration of three steel springs, S^1 S^1 (Fig. 2), two of which are of equal length, while the uppermost third spring is shorter. This construction of springs has been adopted because experiment has shown that the elasticity of the whole system is thus preserved, and the pitch of the note sounded remains the same after many years' use. The first spring is connected with the second spring, and the latter with the third, so that all three swing together. The springs are attached by a screw bolt to the forward edge of a shallow box, B, as shown in Fig. 2. Into the opposite edge, and partly into the sides of this box, are inserted four cutting-off plates, and the springs during vibration pass these plates in both directions, thus producing a larger number of sound waves, and therefore a shriller tone, than would be the case were only one spring and one cutting-off plate employed. The action of the apparatus will be easily understood from our illustrations. When the piston, P, is drawn back in its cylinder, C, air is drawn into the cylinder through the valves, V. On pushing the piston forward the valves close, and the air is discharged from the funnel, F, into the sounding box, S. The air pressure coming on the top of the springs causes these to deflect downward, and momentarily cut off the flow of air when passing the cutting-off plates. The sounding box, S, has at its lower part an enlargement, L, serving as an air buffer to prevent the springs from striking the box. The air is finally discharged by means of the funnel, G, which is protected on the outside by a casing, H. For the transmission of complete messages at sea, two such fog horns are arranged side by side, as shown in our illustration (Fig. 1). One of these is arranged to give a tone of high pitch, and the signals are produced by short or long strokes of the piston, so that the letters of the alphabet can be signaled according to the Morse or any other code. The other fog horn is arranged to give a lower note, and this is sounded after the completion of each letter. By this means the apparatus may be used to communicate with perfect clearness and freedom from error whole sentences. The fact that this fog horn is always ready for use, and does not require any mechanical power, combined with its extreme simplicity and small weight, should make it a valuable adjunct in the equipment of vessels of all classes.—*Industries.*

ADVANTAGES OF OIL AS FUEL.*

By C. N. RANSOM.

THE use of oil as fuel for the purpose of producing steam is still, in a certain sense, an experiment, and yet it is no longer a question of whether it shall be used, but merely a question of the manner and method to be adopted. The general public opinion seems to be that oil must, to a great extent at least, take the place of coal as fuel. The advantages are so obvious that it is hard to find a man who does not believe that some method will be found by which a steady, smokeless, economical and easily controlled flame can be produced from oil by means of which boilers can be heated in a much more satisfactory way than is now done with coal. The great public is tired of coal, with its clinkers, smoke, dust, and ashes, and the necessity of constant attention —not to say anything of the regular "corners," short weight, and extortionate prices.

A large part of this feeling is due to the wonderful development of oil fields and the evident fact that oil can readily be furnished at about half the present prices. The Standard Oil Company, in combination with the Producers' Association, is struggling to maintain the price at a high figure, but the very fact that in order to do so they are now holding back a reserve stock of millions of barrels, which they can at any moment throw upon the market, makes speculators and simply postpones the inevitable result, cheap oil and plenty of it. Meanwhile the California oil wells are extending, and aside from the Pennsylvania and Ohio fields, fields of large extent are discovered in Wyoming Territory and in other sections of the country, to say nothing of the large oil fields of Canada. The export trade for oil is becoming less and is likely to cease entirely, on account of the refineries erected by the Nobel Bros., in Baku, Russia. Hitherto the petroleum found in Russia has been to a great extent neglected, yet the production is said to be so enormous that the daily output of one well at Baku exceeds the daily production of all the wells in Pennsylvania combined. Quite recently Nobel Bros. have taken hold of the business, and have erected extensive refineries, and are understood to be constructing pipe lines, which must result in cutting off all the export trade in oil to Europe, and in throwing back upon the home market all the oil which would otherwise be exported.

In connection with the subject of oil as a fuel in steam making, some points may be stated which are doubtless familiar to most of the members of this association. The term "crude" is applied usually to both the Ohio and Pennsylvania products, but there is a vital distinction. The Pennsylvania "crude" is really worth more than the lower grades of refined oil produced from it, on account of the value of the paraffin, vaseline, lubricating oil, etc., produced from the residue after the lower grade of refined is taken off, mainly by simple distillation. Of course, when the higher grades of refined oil, such as the "astral," are produced, the additional processes required for purifying render the oil more expensive, but as a matter of fact the residue is really worth more than the distillation. The consequence of this fact is that no Pennsylvania crude oil is used as a fuel so far as we can learn. The Ohio oil, however, stands on a different basis. No process has yet been discovered by which refined oil, fit to be used in lamps, can be produced from the Ohio crude. We are informed that large prices have been offered by the Standard Oil Company for the discovery of any process by which it can be done, and that this company has expended large sums of money in trying to do it, but has so far failed. The consequence of this has been an accumulation of over twelve millions of barrels of surplus stock of Ohio oil, for which the market is simply for fuel and so limited that it will not take the oil produced, to say nothing of the surplus. The fact that the residue after distillation is worth more than the distillation is especially true of this oil, and it is stated on high authority that the oil companies could easily afford to sell the distilled product at one cent a gallon and still make money from the residue. In their efforts to produce refined oil from the Ohio crude the Standard company had accumulated several million barrels of distillate, which is not refined and which can be used as fuel if a proper apparatus is devised, but for which there is no large market to-day, and which cannot be sold for use in lamps or kerosene stoves. It is inevitable that these vast quantities of oil must be thrown upon the market, and that the price of oil must go down to a point far below the present one.

It gives one an impressive idea of the magnitude of the commerce of this country to reflect that probably nine-tenths of the vast quantities of oil sold in this country, and upon which such vast fortunes have been made, has been and still is used simply in kerosene lamps and stoves. The quantity of heat which can be developed by one pound of pure carbon is sufficient to boil fifteen pounds of water from at least 212° F., if none of the heat was lost; and one pound of coal of fine quality, under similar conditions, will evaporate fourteen pounds of water, producing 14,133 heat units. The total heat units which can be produced from one pound of petroleum are 27,591, and one pound of petroleum can be made to evaporate 285 pounds of water. These figures are taken from the work on steam boilers of Prof. G. B. N. Tower, formerly chief engineer of the United States Navy, and are believed to be reliable. In fact, other authorities seem to correspond.

The heat-producing value of petroleum, compared with pure carbon, is as 28 to 15; and, compared with a fine quality of coal, as 28 to 14, or 2 to 1; and 1,000 pounds of petroleum are equal to a ton of coal. As petroleum weighs 6½ pounds to the gallon, 154 gallons are equal in heat-producing power to a ton of the present coal. In practice, however, the heat-producing power of coal as used under boilers is very much less than the possible production stated. Referring again to Prof. Tower's work, we find that in actual careful tests of over forty different articles of coal the highest evaporation reached was 10·7, and the other results varied from 6 upward, showing a loss from the estimated possible result of from 30 per cent. to 60 per cent. We have been unable to learn of a single instance in which a higher evaporation than 10·7 has been reached with coal, and have learned of only a few special tests in which an evaporation of over 9 has been reached. Such results have been reached only with exceptionally good boilers with feed water heaters and the best of modern appliances to utilize all the heat, avoid radiation, etc., and with the best of coal and the most careful handling. In regular use, however, even in improved horizontal tubular boilers with all improvements, the usual evaporation is from 7½ to 8¼ pounds of water per pound of coal used, and in ordinary vertical tubular boilers the evaporation rarely exceeds 6 pounds of water to the pound of coal, and is oftener less than more.

All these facts must be taken into account in considering the question of the possible value of petroleum as a fuel. Coal has been the universal fuel, and steam boilers are specially adapted and built for its use. Devices for producing perfect combustion of coal and for utilizing the heat derived from it have been patented by the thousand, and constant familiarity with its use in manifold ways has produced about as good a result with coal as we can well hope to reach, and this result

* A paper lately read before the National Electrical Light Association.

summed up is that whereas one pound of coal can be made in laboratory practice to evaporate 14 pounds of water, yet in common use in good horizontal boilers the average evaporation is but 8, showing a loss of 43 per cent., and in common use in upright tubular boilers the average evaporation is only 6, showing a loss of 60 per cent.

Reverting to our former figures, it is evident that if one pound of oil is equal to two pounds of coal—under laboratory tests where one pound of coal evaporates 15 pounds of water—and 154 gallons of oil equal one ton of coal, then when there is a loss of 43 per cent. on the heat-producing power of coal, as in horizontal tubular boilers, 88 gallons of oil (if there was no loss in using it) are equal to a ton of coal; and in tubular upright boilers, where there is a loss of 60 per cent. in using coal, 62 gallons of oil (if there was no loss in using it) are equal to one ton of coal.

It is evident that if such results as these could be accomplished, and other objections overcome, oil would be in universal use.

Whether such results can be reached or not is difficult to predict. Inventions in the line of apparatus for burning oil to produce steam are comparatively recent. Nearly all of the inventions are in the line of atomizing or injector burners, and there are probably few if any horizontal tubular boilers in which oil is used as a fuel with any but an atomizer or injector. Burners of that description and of one peculiar form or another have been in use for several years. There is probably but little to choose between the different varieties.

The Cincinnati Spring Company wrote last June that they had probably used upward of 10,000 barrels of crude petroleum with atomizing burners and preferred it to coal, and that they had tried all kinds of injector burners, but make one of their own that suits them better. The Michigan Bolt and Nut Works, of Detroit, wrote, on May 14th: "We tried the 'Askins,' the 'Chicago Edwards,' and a simply constructed burner of our own, using gas pipe, and we liked ours as well as any." Studebaker Brothers, manufacturers, of South Bend, Ind., wrote on May 14: "We have not yet determined what make of burner is the best. We have had about as good results with one we made in our own shops as with any." Of this class of burners there are any variety in use, with more or less success. In brickmaking and certain classes of furnaces they seem to be regarded as being very satisfactory.

There have been, however, some serious objections to their use in boilers. In the first place, it is always necessary to make a fire in some other way first in order to produce a sufficient pressure of steam to start the burners, and it seems generally the case that they will not work on less than 30 pounds pressure. One of the consequences is that if the steam happens to run down, it can only be raised again by shutting off the oil, and making a fire of coal and wood. They are therefore of no use except where a long continued high pressure and a constant fire are maintained. Another difficulty with that class of burners is that their practical use seems to be limited to horizontal tubular boilers, where the flame can be allowed to shoot through a long distance without coming in contact with the iron, the flame being thrown generally upon or against fire brick.

Messrs. Keasley & Mattison, the celebrated chemists, of Ambler, Pa., say: "The furnace must be lined with fire brick, and satisfactory results can then only be obtained after the fire brick reaches a white heat. The fact seems to be that in the atomizing process the oil is sprayed in small globules, and if these globules strike a cool surface or one not excessively hot before they are entirely consumed, the result is imperfect combustion and a large amount of smoke. This peculiarity of injector burners seems to render their use impossible in locomotives or vertical tubular boilers. In fact, I have seen letters from at least seventy different leading firms and well known companies, located in almost every part of this country, stating in almost every instance that, while they knew of injector burners, etc., they never knew or heard of an apparatus for burning oil under boilers which did not require the use of steam or compressed air, nor did they know nor had they heard of any apparatus whatever for burning oil used successfully under vertical tubular boilers. I have also seen a letter from the manager of the fuel oil department of the Standard Oil Company stating that he knew of only one burner which could be used under vertical tubular boilers. It is also a fact, I believe, that no burner has yet been brought into general use under house-heating furnaces. I believe it is now generally conceded that the use of atomizing or injector burners cannot be extended to embrace either vertical tubular boilers or boilers of the locomotive or portable type or even horizontal tubulars below 50 horse power. In fact, the system of atomizing does not appear scientific. It seems upon its face a crude and clumsy way of producing combustion.

I believe, however, that the members of this association recognize few impossibilities and certainly are quite convinced that a device can be made by which oil can be burned and which can be easily and perhaps automatically controlled; and it would seem that such an apparatus would go a long way toward solving the problem of isolated lighting. For such a device we must, I think, turn to the system of converting the oil into gas first and then burning it. It seems to me such a system is in accord with the principles of science, and that in no other way can the best results be obtained from the oil. Of this class of devices the greater number have consisted of coils of pipe maintained at a high heat, in which the oil is vaporized and from which the vapor or gas issues in jets and is burned. These coils of pipe, however, I think, without exception, have proved failures, because of the coking or accumulation of sediment. Attempts have also been made to burn oil and water together, which have so far proved unsuccessful, chiefly because of the great difficulty in adjustment and because they have been too complicated. Another defect has been that the vapor issuing from the tubes produced a smoky flame of comparatively small heating power. Still another difficulty has existed in the fact that if, by carelessness, the valves were opened too far, the oil would overflow.

Some time since my attention was called to an oil burner of the vaporizing type which was submitted to several eminent scientists and to a number of practical men and was approved by them. In that burner the oil was first turned into gas, and then gas issuing in small jets was mixed with air before combustion, upon the general principle of the Bunsen burner. The result produced was a steady flame, entirely smokeless, and in some parts the flame was a most intense blue. The flame produced was regular and of large volume. The cylinder was large and capable of producing more gas from the oil than could be discharged under light pressure through the jet holes, and the tank was elevated so as to give a gravity pressure of about four or five pounds to the square inch. The result was that the gas stood in the cylinder at an even pressure exactly equal to the gravity pressure, maintaining the steadiness of the flame, and no oil would flow into the generator except as the pressure was lessened by the consumption of the gas, even when the fuel valve was opened wide.

Whether that particular device was or is the best or not, it seems to me that some device constructed upon that line must produce the best results attainable, viz., the oil should be turned into gas and the gas burned after admixture with air upon the same principle as ordinary gas is burned in stoves. Some of the advantages which a successful apparatus for burning oil would have are easily understood, and are: Steady flame, perfect control—slight draught required—the power to increase or decrease the flame at will by the simple turning of a valve—the power to maintain steam at a steady pressure—the slight attention required—the power to instantly extinguish the fire without waste—the uniform heat—no reduction of fire or pressure when replenishing the fire—cleanliness—safety—economy in labor—no dust, cinders, or ashes—less room required to store the fuel, and only one-third the weight.

With these advantages to be derived from the use of oil as fuel, it seems only reasonable to expect that within the near future some successful apparatus will be brought into general use for manufacturing and house heating purposes.

THE USE OF DIVI-DIVI IN TANNING LEATHER.

By E. G. THORPE.

IN tanning with divi-divi, carefully selected pods deprived of their seeds should be used. They may be reduced to powder, or roughly broken, and infused in either cold or warm water. Divi-divi may be used either as a pure or mixed tannage, *i. e.*, skins soaking in divi infusions may be stratified with layers of the material itself or with layers of other tanning material, or, *vice versa*, infusions of other material may have layers of divi-divi for stratifying skins and hides soaking in them.

This plant possesses certain advantageous qualities that ought to find favor with tanners, were it not that they are more than counterbalanced by its bad qualities. It is rich in tannic acid, containing from 30 to 40 per cent., and if tannic acid alone were taken as a standard in estimating the value of tanning materials, divi-divi would take the palm of most others. But tannic acid, though the chief, is not the only factor in the formation of leather; it simply forms *tannogelatine*, and it requires something more than tannic acid to form real leather. Experience also teaches that in course of manufacture skins and hides while soaking in infusions of bark, etc., stratified with layers of the material used in order to facilitate absorption, absorb other matter held in solution besides tannic acid. This soluble matter contains coloring matter, and characterizes the leather when tanned, giving it color and other qualities desirable or otherwise. It is known in the trade as extractive "matter." Leather, like all other commodities, in order to be marketable, is judged by a certain standard, such as color—from a light brown to a cream. It must be mellow, close in texture, silky to the feel in case of skins, and firm though pliant in the case of hides. In fact, it must take the eye. Such being the case, it is quite natural that a tanner will look about him for some material yielding an extractive matter producing these results, and such a material we have in the bark used in the Madras Presidency.

Divi-divi possesses the excellent and much desired property of giving weight to leather, but yields an extractive matter producing most disagreeable results; it imparts a reddish brown color to the material, which is very often horribly streaked. It also possesses that worst of all properties, gallic fermentation, which may be reckoned among the worst of the tanner's enemies, as it is a great source of loss and annoyance to him, though in its way gallic acid is very useful to him. All materials containing tannic acid are subject more or less to gallic fermentation, but divi-divi possesses this property in an extraordinary degree, fermenting rapidly under an increase of temperature even in the presence of antiseptics; so that it is not suited to India, where more favorable tanning materials abound, and where, in the absence of scientific skill in the trade, these difficulties cannot be contended against. From a few specimens of divi tanned leather that I have by me I find that it is influenced by the weather, having the peculiarity of being firm in the dry and soft and flabby in the wet weather. In some of my experiments with divi-divi, when the temperature of the atmosphere had risen, I found that gallic fermentation had set in within a few hours, so much so that I suspected the presence of foreign matter and had other vessels scrupulously cleaned, and into these I introduced fresh infusions, together with a small quantity of an antiseptic, and found that gallic fermentation had set in, though not in so marked a degree as without the anti-ferment. It was only by means of an anti-ferment that I succeeded at all in tanning with divi-divi. From the iridescent, oily appearance of the surface of the infusion I infer that the rapidity with which divi-divi ferments is due to the presence of a soluble oil or fatty matter; but with the limited quantity at my disposal I was unable to make further experiments to bear out this inference, which, after all, may be a mistaken one. Divi-divi should find favor in Europe, where tanning materials are scarce, as it has certain advantages over other imported materials, such as its comparative cheapness, richness in tannic acid, and its excellent weight-giving property. Moreover, its disadvantages can be better contended against where the climate is more favorable, and where science and modern appliances are brought to bear on them with very favorable results.

Science in all its branches is making giant strides in this wonderfully progressive century of ours, and the tanning community—hitherto a few centuries behind time, contented to walk on the same lines chalked out by their forefathers—are awaking to the fact that science must go hand in hand with their trade as it does with most others, with the result that ere long obstacles supposed to be insurmountable will yield to its influence. Probably in the near future divi-divi will, in the estimation of tanners in Europe, rank among their chief imports. In conclusion, I would suggest to those who have both the means and leisure, and are interested in seeing this article a commercial success, to make an extract of it, as tanners in Europe affect extracts preferably to the materials themselves. An extract would be more advantageous to the exporter, as it would find more ready sale than the material itself, provided it is free from foreign matter; moreover, the cost of freight is comparatively far cheaper.

In making the extract good-colored and well-matured pods should be selected, and all discolored and decayed ones rejected. The pods may be roughly broken, or reduced to powder and digested in hot or cold water, the latter where a good colored extract is required, and the former where tannic acid is the chief object. Another suggestion I would make is to mill the pods prior to making an extract, in order to see if oil in any appreciable quantity can be obtained. A quantity of carefully prepared extract, sufficient at least for a fair, if not exhaustive, trial should be sent either to Europe or to some local tanner willing to make experiments with it himself, without intrusting it entirely to the hands of his servants.—*Madras Mail.*

SALT FROM SEA WATER.

By GEORGE P. MERRILL.

WHETHER or no common salt is an absolute necessity to animal existence is as yet a problem among physiologists. That it is commonly so considered seems to be conclusively shown by the fact that upward of 2,887,000 tons of the article are annually produced by Great Britain and the United States alone, a large proportion of which is consumed either directly as a seasoning for food or indirectly as a preservative. Barbarous tribes in countries where salt is as yet unknown in appreciable quantities will travel long distances to obtain what is, to them, a great luxury, while the habits of wild animals in resorting to salt marshes and springs, as displayed in the "salt licks" of the West, is too well known to need further mention. Whether this widespread, almost universal, indulgence on the part of man and beast is but a mild form of dissipation, another manifestation of that wholly unwise, unnecessary, and even demoralizing tendency shown by biped animals in resorting to bar rooms, is a question we will not discuss here. The substance is, however, known to be the chief salt of the gastric juice, is stated, on good authority, to be essential to the formation of the bile, and of the greatest importance in the processes ministering to the nutrition of the body.

That, on the other hand, the substance may be positively injurious when its use is carried to extremes is shown by innumerable cases of scurvy resulting from a prolonged diet on salted food. We are perfectly safe in assuming, however, that, if not absolutely essential to animal existence, salt is at least a prime factor in conducing to animal comfort, and may well congratulate ourselves on its being one of the most widely disseminated of all natural substances. The oldest and most deep-seated rocks contain its tiny cubes locked up in cavities so minute that tens of millions could be crowded in a single cubic inch of space. The air we breathe and the purest of natural waters contain it in quantities readily detected by chemical methods. The perspiration of our bodies is distinctly salt to the taste, and even the tears we shed, indicative of grief or wrath, are bitter with saline matter.

Being one of the most readily soluble of all natural substances, salt is everywhere diffused and transported by percolating waters, and every running stream bears its relative proportion down to its ocean, the common reservoirs of animal waste and continental denudation. Here, being non-volatile at ordinary temperatures, it has slowly accumulated, sometimes even to the point of saturation, and been deposited, forming, since time began, beds of varying thickness and degrees of purity. Thus it is that all bodies of water with no outlets become charged with mineral matter, though, naturally, not all in the same proportion, much depending on the size of the body, the number of its tributaries, and the character of the formations over which they pass.

The waters of the Atlantic Ocean, as shown by the chemists of the Challenger expedition,* display over a wide area a remarkable uniformity in composition. The results obtained show that on an average these waters carry about 35 parts in 1,000 of inorganic salts, of which Dittmar calculates some 77·758 per cent., or 27·25 parts in 1,000, are sodium chloride, the remaining 22·242 per cent. being chiefly chloride and sulphate of magnesia, sulphate of lime, sulphate of potash, bromide of magnesium, and carbonate of lime. The enormous quantities represented by these figures can be best comprehended by a reference to the computations of T. Mellard Reade.†

On the basis of Dr. Frankland's determinations of 3·259 parts of chlorides (chiefly common salt) to every 1,000 parts of sea water, this authority computes the total amount of salt held in solution by the waters of all the oceans to be some 21,295,000,000,000 tons, or, reckoned at the rate of 16 cubic feet per ton, and the area of all the land in the world at 51,000,000 square miles, enough to cover the entire land surface of the world with a deposit 914·9 feet in depth! To say, then, that a man is not worth his salt may be considered sufficiently explicit and condemnatory to meet the needs of most cases in which utter incapacity and indisposition to exertion are controlling characteristics.

The manufacture of salt by the evaporation of sea water dates, in this country, from a comparatively early period. As early as 1620 works for this purpose were established in Virginia. Little, however, was accomplished, and it remained for the colonists about Massachusetts Bay to fully inaugurate the marine salt industry of the United States. In 1622 small works for producing salt by boiling sea water were put in operation near Plymouth, in this State, and the year following works were established near the mouth of the

* *Physics and Chemistry*, vol. i.

† Chemical Denudation in Relation to Geological Time.

Piscataqua River, in New Hampshire. With what success these attempts were attended we are not informed, but it is stated that as early as 1624 the colonists sent a cargo of fish to England cured with salt of their own manufacture. That the industry was early recognized as of importance and worthy of encouragement is shown by various letters and laws bearing upon the subject. In 1641 it is reported that a Mr. John Jenny and others were allowed certain privileges that they might carry on the manufacture of salt at Clarke's Island, said salt to be sold to the inhabitants at the rate of two shillings a bushel. Again, it appears that in 1652 Moses Pengry was "granted a parcel of land by the warehouse, below Obadiah Wood's fence, to set up his salt pans and works and fence in his wood, also liberty to fell wood near the town for his use." In 1641 also the General Court of Massachusetts passed an act to the effect that "Whereas, Sam. Winslow hath made a proposition to this court to furnish the county with salt, and to make it by means and ways which hitherto have not been discovered," the said Samuel should have the privilege of setting up his works and enjoying the monopoly of the same for the space of ten years.

From about this date many small and often ineffectual attempts were made to profitably manufacture salt from sea water by natural evaporation only. These were only in part successful, owing to the crudity of the apparatus and the humidity of the atmosphere. The high price of the imported salt, induced by war with Great Britain, however, gave stimulus to the enterprise, and during the years intervening between 1776 and 1837 a large number of works were established and in successful operation all along the Atlantic coast, but particularly in Massachusetts. At the last named date Massachusetts alone manufactured 758,392 bushels of salt annually, over one-half of the amount being produced in the single county of Barnstable on Cape Cod. In 1829 marine salt works were in operation in Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Delaware, Maryland, Virginia, and in North and South Carolina, in all some 122 establishments, covering not less than 20,510,420 square feet of territory, and producing yearly some 727,049 bushels of salt. With the lowering of the duties on the imported article, which began shortly after this, the business soon became unprofitable, and in 1855 the entire product of Massachusetts had diminished to less than 1,000 bushels annually, at about which figure it still remained at the time of the taking of the tenth census (1880).

The method of procedure in preparing salt from sea water differs very little to-day from that in vogue in the earliest stages of the industry, and depends for its efficiency upon the fact that sea water, as already noted, contains, besides sodium chloride, various other salts, but which, owing to their varying degrees of solubility, may be, on evaporation, deposited at different stages of the concentration. In Massachusetts the process was as follows: A series of about four wooden vats or tanks were made of planks, with nearly vertical sides, and about one foot in depth. These were set upon posts at different levels, and so arranged that the brine could be drawn from one to the other by means of pipes which could be opened or closed at will. Into the first or highest of these tanks, which was called the "long water room," the water was pumped direct from the bay by means of windmills, and there allowed to stand exposed to evaporation for a week or ten days, or until all the sediment was deposited. In the second vat, or "short water room," the water was allowed to stand but two or three days. It was then drawn into the third vat or pickle room and allowed to evaporate until all the lime held in solution was deposited on the bottom and sides of the tank, and a thin pellicle of salt began to form over the surface; the brine was then drawn off into the fourth and last vat, where the final concentration took place and the salt crystallized out. Care needed to be exercised in this last stage, lest the evaporation should be carried too far, and sulphate of soda (Glauber's salt) be deposited, to the detriment of the final product. At one time it was the custom to draw this residual liquor, or *bittern* as it is called, into a fifth tank and allow it to evaporate until the Glauber's salt was precipitated, which was saved for medicinal purposes.

As to the capabilities of the works as above described, it may be stated that during a dry season vats covering an area of 3,000 square feet would produce about one hundred bushels of common salt and four hundred pounds of the Glauber's salt. As it requires from 300 to 350 gallons of sea water to produce one bushel of salt, a slight computation will show that some 32,500 gallons must therefore have been evaporated from each 3,000 square feet of vat space.

The climate of the eastern United States proved, however, too moist for solar evaporation alone conducted in open vats, and it was found necessary to cover the works by roofs arranged by means of rollers to be slid one side in fair weather, and to protect the vats during rainy seasons. Such an arrangement from necessity increased the costs, and this together with the fall in prices shortly rendered the business unprofitable.

The coast of California is peculiarly adapted to the manufacture of salt from sea water by solar evaporation, owing to its almost entire exemption from rains during the summer months. Hence, while owing to causes above enumerated the works have been almost wholly discontinued in the Eastern States, there has been a corresponding increase on the Pacific coast; and to-day, although the number of works in the entire country is less than one-fifth that of former years, yet owing to the magnitude of the Western works the present area devoted to evaporation and the annual product are both greater than before.

The methods of procedure in the California works do not differ materially from those already described, excepting that owing to the dryness of the climate no roofs are required to protect the vats, and which can therefore be made much larger. In many cases, moreover, the evaporation is not conducted in wooden vats, but upon the surface of the ground. One of the principal establishments in Alameda County is situated upon a low marsh, naturally covered by high tides, and which has been divided by means of piles driven into the mud and by earth embankments into a series of seven reservoirs, all but the last of which are without wooden or other artificial bottoms. The entire area included in the seven reservoirs is about 600 acres, necessitating not less than fifteen miles of levees, and the entire capacity of the works is estimated at some 30,000 bushels annually.

The season of manufacture is from May to October. At the beginning of the spring tides, which rise some twelve or eighteen inches above the marsh level, the outer gates of reservoir No. 1, comprising some 300 acres, are thrown open and the waters of the bay allowed to flow in. In this inclosure the water is allowed to stand for about two weeks, or until all the mud and other filth held in suspension has been deposited. It is then, by means of pumps driven by windmills, forced from reservoir to reservoir as the concentration proceeds until it finally reaches the seventh and last as a strong brine. Here it is allowed to stand until the salt crystallizes out, when the bittern is pumped back into the bay, and the salt, after washing and drying, is shoveled up and removed to the storehouses.

The schoolboy's definition of salt as the "stuff that makes things taste bad when you don't put any on," though perhaps lacking in elegance, and of rather a negative character, is, I am inclined to believe, fully as definite and explicit as could be given offhand and in the same number of words by the majority of persons. But all salt, whether made direct from sea water, brines from wells, or mined as rock salt, is not of equal value either as "stuff to make things taste bad" when you *don't* put any on, or as an antiseptic. All commercial salt is more or less impure. Common among these impurities are sulphate of lime (gypsum), iron oxides, and common clay, besides which there are usually traces of the chlorides and sulphates of potassium, magnesium, and calcium, as well as traces of bituminous matter. A few varieties are rendered objectionable by the presence of infusoria and minute algæ. In sea salt the chief impurities, as may readily be understood from what has been said regarding the composition of sea water, are the chlorides of lime and magnesium, the sulphates of lime and potash, carbonate of lime, and traces of iodine and bromine. These impurities as found in the commercial salt are, however, due largely to hasty and imperfect methods of manufacture, and can in large part be eliminated by proper care. That salt as it appears on the table or in the dairy contains a very considerable proportion of dirt or earthy matter may be readily shown by dissolving a small quantity in a glass of clear water. This test does not however show the full amount of impurities, since the chlorides and sulphates mentioned are equally or more soluble than the salt itself, and hence become invisible. A mere analytical statement giving the percentage of sodium chloride or of impurities in a salt, without stating the character of these impurities, is of little value, since, as stated by Dr. Groessman,* the various kinds of foreign ingredients are objectionable in quite different degrees. Salt containing from one to one and a half per cent. of impurity in the form of carbonate of lime may be a fair article, while one with half that amount of the chlorides of magnesium and calcium or of the sulphate of soda and magnesia together with the chloride of magnesium, or the carbonate of lime and magnesium, would be very objectionable for dairy purposes. The presence or absence of the more highly deliquescent of these impurities also has an important bearing upon the amount of moisture and consequent caking tendency manifested. All must have observed that certain brands of salt will remain light and dry for any number of days, while others will cake in the vessel whenever there is the least humidity in the air. Of all the impurities yet found in salt, there are probably none that have been more disastrous in their effects than that a few years ago discovered in the imported Cadiz salt which is so extensively used in curing fish at Gloucester, Massachusetts, and other fishing towns along the coast. For several years prior to 1878, the Gloucester dealers lost heavily, from the fact that the freshly salted fish, instead of remaining white and firm, shortly became soft and spongy, assumed a reddish color, and quickly decomposed, becoming a dead loss to all concerned. Acting on a suggestion of Prof. Baird, the United States Fish Commissioner, Dr. W. G. Farlow, the well-known cryptogamic botanist, investigated the cause of this trouble, and found it to be due wholly to the presence of microscopic algæ, of a reddish color, and to which is due the characteristic color of the Cadiz salt. When this was spread upon the moist fish, it quickly began to grow, in much the same manner as mould upon any damp surface, and speedy ruin followed.

As, however, it was discovered that the plant did not thrive at a temperature below 60° Fahrenheit, it remained but for the dealers to keep the temperature of their storehouses below this point and all trouble would be avoided. In conclusion it may be well to state that out of the 29,905,298 bushels of salt manufactured in this country during the census year, but 887,968 bushels were made from sea water and by the processes described. The remainder was the product of salt wells, springs, or mines in various States, particularly in New York, Michigan, Ohio, Pennsylvania and West Virginia. In 1886 our total product from all sources was 1,078,991 tons, or 41,499,692 bushels. Aside from what is consumed directly by man and the lower animals, a very large proportion of the supply is used for antiseptic purposes and in various chemical processes, as chloridizing ores.

* *Silliman's Journal*, 1870, p. 78.

INDUSTRIAL APPLICATIONS OF OXYGEN.

AT a recent meeting of the Society of Chemical Industry, Dr. T. L. Thorne read a paper on "Some Industrial Applications of Oxygen." The author said that Brin's oxygen plant is now produced at so low a cost as to bring the gas within the range of industrial applications, some of which have been already worked out. In London the gas does not cost more than 7s. 5d. ($1.75 per) thousand cubic feet to manufacture, and where coal is cheap the cost of production will fall to 5s. = $1.20. Of late the makers have been keeping the furnace at a temperature of about the mean between oxidation and deoxidation of the baryta. Air is forced in by pressure and drawn off by a vacuum, and this plan is found to be more economical than the older method of considerably changing the temperature of the furnace.

The true agent in bleaching operations is almost always oxygen, as shown in the example of the bleaching field and the action of sunlight. For the oxygen to act, it been thought necessary that it should be in the nascent state or in the condition of ozone; but recent experiments have proved this idea to be true only up to a certain point, for when oxygen is used in conjunction with chlorine, it possesses considerable bleaching power upon paper pulp, and other substances. Experiments with pulps have been carried out on a practical scale. A stream of oxygen has been pumped into a mixture of chlorine and paper pulp, and was found to accelerate the bleaching. At first it was thought that this might be due to stirring up; consequently, nitrogen was pumped in instead of oxygen and the bleaching was then found to be retarded. When common air was pumped in, the ordinary bleaching result was obtained. The residual liquid in the batch with which oxygen had been mixed always contained more available chlorine than the others. Experiments were next made in a closed churn. Oxygen was pumped in, and absorbed by the pulp without increasing the pressure in the churn, but when nitrogen was pumped in, the pressure rapidly increased; oxygen, therefore, was used up, and helped in the bleaching.

In some additional experiments the use of oxygen was found to reduce the amount of bleaching powder necessary to the extent of 40 or 50 per cent., and it was discovered that much depended upon the fineness of division of the oxygen in the solution. The method was tested on a large scale in a paper mill, and 50 tons of material were treated in about five days. The vessels used being shallow were not favorable for the proper admixture of oxygen. The liquid in them was 20 inches deep. The oxygen was admitted through a perforated pipe a little in front of and nearly underneath the beater.

The chloride of lime, introduced on the other side of the partition of the poacher, began to bleach strongly, and as it was twenty minutes before it came round to the beater, much of its bleaching power had thus been previously destroyed. Even under these disadvantageous conditions, 30 per cent. of saving was effected in the bleaching, and with suitable apparatus a larger saving could be effected. The addition of oxygen diminishes the amount of damage done to the fiber, and increases the tensile strength of the paper produced about 8 or 10 per cent. In another experiment, some mixed chlorine and oxygen were pumped into a closed chamber containing jute, yet the oxygen was so absorbed that the pressure did not rise much. The best results were obtained when the oxygen was mixed with the chlorine in the generating chamber of the latter. Why these effects were produced, the author did not know; possibly the oxygen regenerated the chlorine in some way, or possibly part of the oxygen was converted into ozone in the presence of nascent chlorine.

The author said that oxygen can also be used in the purification of gas. The oxide of iron has now often to be revivified by exposure to the air; sometimes the effect is obtained by adding a little air to the gas passing through; but the disadvantage of this plan is that the nitrogen in the air diminishes the illuminating power of the gas. With a trace of oxygen insufficient to attack the carbon too rapidly, the illuminating power of the gas is increased. It has been found, moreover, that its use permits the entire abandonment of oxide of iron, and that the lime purifiers can then do the work alone. The sulphur also becomes to a large extent fixed in the lime as free sulphur, so that the product has not the noxious smell of "blue billy." The trial has extended over eight months, and the process is about to be worked at Ramsgate, where any one interested in gas manufacture will be able to inspect all the operations.

Another use to which oxygen can be put is the maturing of spirits. This problem has been only partly worked out; but oxygen compressed into spirits and kept therein for ten days mellows them as if they had been kept for several years. In an experiment he had made with whisky, the spirit before treatment with oxygen contained 0·28 gramme per liter of fusel oil, and after treatment 0·06 gramme. In another experiment the quantities were 0·3 gramme before treatment and 0·02 gramme after. The process has been used for some time in one or two large distilleries in France. It is doubtful whether it can be applied to wines with advantage; but perhaps it will answer with some of the stronger and coarser varieties.

The chairman, Mr. David Howard, considered it to be astonishing that so widely diffused a substance as oxygen should have been so shut out until recently from industrial pursuits. With the exception of Deville's furnace for platinum, oxygen had not been used in metallurgical chemistry.

Mr. S. H. Johnson said that great expense was incurred in handling lime at gas works, and he did not see how that would be abolished by the use of oxygen. As to the oxide of iron, it was worth more when it left the gas works than when it arrived at them.

Mr. Newlands wished to know how Dr. Thorne estimated the presence of such small proportions of fusel oil. A French chemist had told him that it was impossible.

Mr. Bevan wished to know if the whiteness due to the addition of oxygen was permanent in the bleached goods.

Dr. Alder Wright stated that oxygen forced into water made an effervescing drink as tasteless as ditch water.

Mr. C. T. Kingzett said that in revivifying oxide of iron, the great thing was to bring it back to ferric oxide. If magnetic oxide of iron were to be formed, it would be useless in gas works.

Dr. Thorne remarked that 1,000 ft. of oxygen weighed 83 lb., and the oxygen produced therefore cost about a penny a pound. The ordinary cost of bleaching paper pulp was about 15s. or 18s. per ton of raw material. The use of oxygen on a large scale had saved 30 per cent. of that, or about 5s. Messrs. Spalding & Hodge had been sufficiently satisfied with the process to resolve to adopt it at their great paper works in Kent, and were on the point of setting up the plant. He agreed that there was great difficulty in determining the amount of fusel oil in spirit, but he had had the advantage of comparing the same spirit before and after treatment, so could get at nearly the relative values. He believed oxygen-bleached materials to have a more permanent whiteness than those bleached with chlorine only. Peroxide of hydrogen would do for bleaching ivory and other substances in regard to which expense was no object, but the cost of using peroxide of hydrogen was too great to enable it to compete with chlorine and oxygen. Two volumes of oxygen, with one of chlorine, gave the best results; with more oxygen the results were stationary, and with a large excess there was a falling off in bleaching effect

BISULPHIDE OF CARBON: ITS MANUFACTURE AND PURIFICATION.*

By IGNATIUS SINGER.

BISULPHIDE of carbon is prepared by passing sulphur vapors over red hot charcoal in a closed vessel; the sulphur combines at this high temperature with the carbon, and CS_2 distills over, which may be condensed. The combination of the two elements being direct, and the reaction of the simplest kind, its preparation would seem to be very easy. Nevertheless many difficulties attend its manufacture—chiefly on account of its great inflammability and the poisonous nature of its vapors—which, however, are purely technical, and will therefore command most of our attention.

On a small scale it may be prepared by heating fragments of charcoal in a porcelain or iron tube to redness, and passing sulphur vapors through it. This is both a tedious and a dangerous way and never employed at present, as CS_2 is now made on a very large scale. Vertical iron or earthenware retorts, about 6 feet high and 22 by 12 inches internal diameter, are now used, capable of making from 4 to 5 cwt. per 24 hours. Great care is necessary to prevent all access of air into the apparatus, as bisulphide of carbon vapor mixed with oxygen or air forms a powerful explosive, which, in itself often disastrous, is still further aggravated by the creation of two poisonous gases, thus:

$$CS_2 + 3O_2 = CO_2 + 2SO_2,$$

leaving the nitrogen as a third irrespirable gas. From this it will be seen that the greatest care is necessary to make all joints perfectly air tight, and above all to exclude air from the generating retort, as no bisulphide is formed while oxygen is present, the sulphur having a greater affinity for this than for carbon. But this was at first by no means an easy matter, as the retort must have several openings for introduction of sulphur and charcoal—the former every few minutes—for the delivery of the vapors and the withdrawal of the ashes; while the necessarily high temperature makes it difficult to find a suitable cement to insure tightness.

Another difficulty—and perhaps the greatest of all—is occasioned by the large quantity of uncombined sulphur which distills over, and has a tendency to choke up the exit pipes and condensers. Hence every few days the apparatus has to be opened to remove this accumulated sulphur, an operation not at all free from danger, unless proper arrangements have been made to facilitate this part of the work.

From these preliminaries it will be easy to gather what should be the leading features of a good bisulphide of carbon apparatus, and may be summarized as follows:

1. Absolutely air tight joints throughout the apparatus.
2. Easy introduction of the sulphur, without admission of air.
3. Easy access to all parts for the purpose of removing sulphur.
4. The charging in of carbon should be quick, and while cleaning out the apparatus, the condensing part should admit of being isolated from the retort to prevent sparks entering from the latter into the former.

These points will be more fully explained as I proceed to describe the modes generally employed.

The first to manufacture CS_2 on a commercial scale was Peroncel, in France, about 40 years ago. This apparatus being the oldest is necessarily the most imperfect. It is shown in Fig. 1. I have purposely selected this as one of my illustrations, since in noticing its defects it will afford us good opportunity to study what to do and what to avoid in the erection of a good plant.

The illustration is taken from Richardson and Watts' Technology, where the following description of it is given:

"A is a metal cylinder carefully coated on both sides with fire clay. It was fixed on a solid metal support, B, and the whole was surrounded with brickwork, CC. The lid was cast with two openings, E E, through one of which an earthenware pipe, *c*, descended nearly to the bottom of the cylinder, the lower end resting on hard burnt coke, with which the cylinder was filled. As carbon passed off during the operation, in combination with the sulphur, its place was supplied by fresh charges of coke, which were filled in through the other opening, E, in the lid. A metal arm, H, cast with the cylinder, was connected with a pipe, I, that was ground in at one end, the other passing to an earthenware carboy, J. A pipe with a cock, K, was attached to the bottom of the carboy, which carried the liquid into a Florentine receiver partially filled with water. This receiver discharged the bisulphide of carbon into a close vessel, O, by a pipe, M, from which it could be drawn off by a cock, N.

"The uncondensed vapor escaping from the carboy passed through another earthenware pipe, P P, to a worm, G, made of zinc or earthenware, which was kept cool by a current of water. The bisulphide of carbon ran off at R into another close vessel, S, furnished with a cock.

"The space between the metal cylinder, A, and the brick work, C C, is partially filled with fuel, which, when ignited, is supplied with air through the opening, D D, and the products of combustion escape at *t*.

"The fuel is now ignited, and the cylinder gradually heated until it becomes red, when pieces of sulphur are thrown down the pipe, *c*, at intervals of a few minutes. The sulphur is converted into vapor, which, coming in contact with the red hot coke, combines with the carbon, producing the bisulphide of carbon.

"The cylinder," we are told, "lasts only about a week, and when made about 6 ft. long by 1 ft. diameter, it will produce about 2 cwt. of bisulphide of carbon per day."

This last statement is, in itself, a very serious matter, as to remove the old and replace a new retort the furnace must first be allowed to cool down, portions of the brickwork removed, and subsequently restored again and heated up to redness, which would entail the loss of at least one week's work; besides this, the heavy expenditure in labor, fuel, and material, all of which expenses would have to be borne by about 14 cwt. of the product. At present retorts are constructed to make at least 4 cwt. of bisulphide per day, and which last 60 days and more, thus spreading nearly the same expense over a quantity about seventeen times larger than the former, lessening its cost in proportion. I may also mention that at present charcoal is used exclusively, it having been found to yield larger quantities than coke.

The furnace itself is constructed on bad principles, as it would consume more fuel for a given result than would otherwise be necessary. Instead of surrounding the retort to nearly half its height with fuel, whereby the lower portion of the retort is liable to be kept cool and result in a less yield, the fuel ought to be burned in thin layers on a grate, as in boilers, and the air admitted from underneath the grate only, and so arranged that the flame and hot products of combustion should circulate all round and the whole length of the retort. By this not only a greater caloric effect would be obtained from a given quantity of coal, but the retorts would be more uniformly heated, and yield a larger quantity of bisulphide. Again, by placing several retorts in one furnace a great saving is effected in fuel, labor, and general expenses.

A great loss in bisulphide must have been occasioned by the frequent removal ("every few minutes") of the lid, *c*, for the purpose of introducing the sulphur, not to speak of the inconvenience caused by the sulphurous acid vapors to the men attending to this operation. But the worst feature in this apparatus is its condensing arrangement. As already pointed out, considerable quantities of uncombined sulphur pass over with the bisulphide, crystallizing out on their passage through the condensers and causing great annoyance. This sulphur has to be removed from time to time, hence the condensing arrangement ought to consist of straight pipes only, worm condensers being altogether inadmissible. In Peroncel's arrangement the carboy, J, is evidently intended to retain this sulphur; but although the greater part of it would condense here, sufficient quantities would be carried over into the worm, whence its removal would be impossible without destroying the worm itself, while the carboy would present similar difficulties.

There is yet another point that demands attention, and for which no provision seems to have been made in this apparatus. The charcoal contains a considerable amount of hydrogen, which gives rise to the formation of sulphureted hydrogen. When the retort is freshly charged with charcoal, no bisulphide of carbon is formed until all the hydrogen present has passed off in combination with sulphur. Means must be provided to carry off, and if possible to absorb, these deleterious vapors. How this may best be done will be shown further on.

Among those who improved most largely on Peroncel's arrangement, Deiss deserves special mention. In Stohman and Engler's edition of "Payen's Industrial Chemistry," it is stated that within a few years he reduced the price of bisulphide of carbon from two francs per ounce to fifty cents per pound. At present it can be manufactured at a cost price of one penny per pound or thereabouts.

Without stopping, however, to trace the successive improvements that have been made since Peroncel, I shall now describe what I consider to be the best apparatus of to-day. Having manufactured this substance, I am well acquainted with all the technical difficulties attending its production, and in the illustrations herewith I shall make various suggestions by which some of the sources of annoyance yet existing might be obviated.

I hope I may be pardoned for entering rather fully into details, in which I think I am amply justified by the industrial importance this substance has of late achieved, especially if we consider that our literature has not kept pace with its rapid development, and that but few of our handbooks describe its mode of manufacture, and those only giving more or less obsolete methods.

Fig. 2 shows a side elevation in section.

A is a vertical cast iron retort, or, better still, made of earthenware, glazed inside, of elliptical shape, about 66 in. high and 20 by 12 in. internal diameter. It rests on a support, B, made of fire-bricks, and is protected by a mantle of best fire-bricks, C, about 4 in. thick, leaving a space of from ½ to ¾ in. between it and the retort. The metal of the retort should not be less than 2 in. in thickness. D D is the outer brickwork of the furnace, lined on the inside with fire-bricks, D' D', E E are fire grates; E^1 E^1, ash pits; F F, furnace doors, made of frames, *a*, into which a fire-proof slab, *b*, is inserted. The furnace doors are suspended by cables running over pulleys, and are counterpoised, so that they can be raised or lowered. At *d* is shown a small peep hole, through which the temperature in the furnace may be watched, a matter of the greatest importance, as we shall see presently.

In the lid of the retort are cast two tubes, G and G', of about 5 in. internal diameter, and not less than 1 in. in thickness; but it is advisable to have them made somewhat stronger, as the lid will then outlast several retorts. Over the opening, G, a vent pipe or flue, H, is suspended by a lever, so that it can be raised or lowered at will, one end of which passes through the roof. When fresh charges of charcoal are to be introduced into the generator, A, which is done through the tubulure, G', the lid closing the tube, G, is first removed, and the vent pipe, H, quickly lowered, which serves the purpose of carrying off the noxious gases that would otherwise be injurious to the workmen. G' may now be opened, and the carbon fed in without the slightest inconvenience.

From the tubulure, G', issues a pipe, I, inclined upward, through which the bisulphide of carbon vapors escape. Most of the free sulphur passing over will condense here and run back into the retort. But the partially cooled sulphur falling onto the surface of the incandescent carbon would be immediately vaporized again, at the same time cooling down the top layer of the charcoal. To obviate this, I would suggest an opening should be made in the lower part of the pipe, I, to which a hopper can be fitted, as shown at J, terminating in an earthenware pipe, K, reaching nearly to the bottom of the retort. By this means the sulphur distilling over uncombined would be conducted back to the bottom of the generator, the pipes would be less liable to be choked up, while the resulting product would be purer.

From the lower end of the retort, close to the bottom, a pipe, M, is branching off, a little upward inclined, passing through the brickwork, and terminating in a chamber, N, with door, *n*. During work this pipe is carefully closed by a lid. It serves the purpose of raking the ashes out of the retort, which is done once a week. At *m* a flue is shown, carrying the noxious gases into the chimney. The ashes are allowed to cool here before their removal. Adjoining this chamber is a hearth into which an iron vessel, O, is fitted.

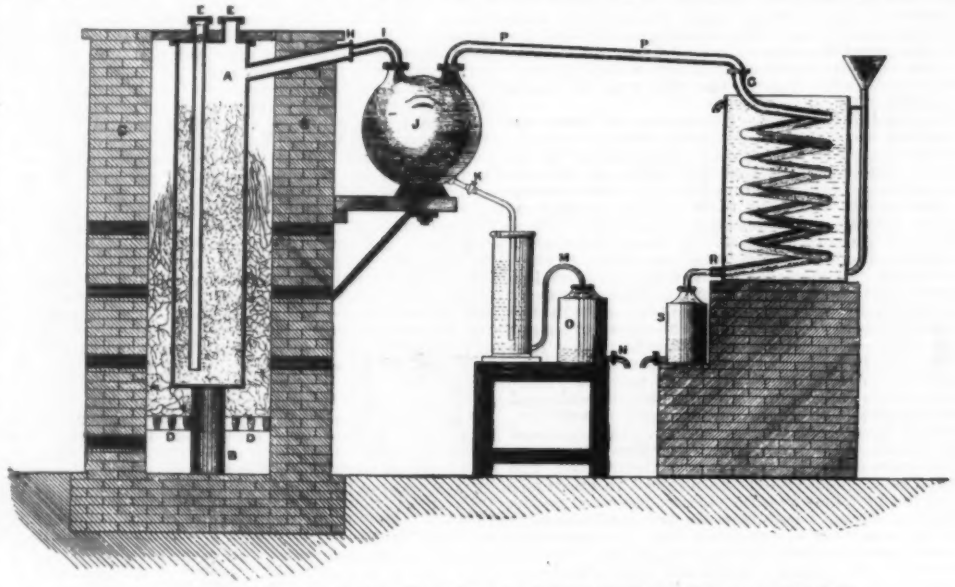


FIG. 1.—MANUFACTURE OF BISULPHIDE OF CARBON.

for melting the sulphur. It is heated by a flue from the furnace passing underneath it, provided with a damper to regulate the heat. (In Fig. 2 this sulphur vessel is raised so as to make it visible in the drawing.) A pipe, *o*, closed by a conical valve to which an iron rod, o^1, is attached, connects the sulphur pot with the arm, M, of the retort, by which means the sulphur can conveniently be introduced into the latter.

The sulphur flowing down the incline of the arm, M, arrives at the bottom of the retort, where it is volatilized; the vapors passing upward combine with the carbon. The general bisulphide vapors escape through pipe, I, and then pass down the vertical tube, I^1, into a vessel, P, where any excess of sulphur is deposited. The lid of this vessel rests in hydraulic seals, and is connected with the inlet and outlet pipes by a kind of telescopic tubes made air tight by water, as shown in drawing. When the vessel, P, is to be removed, the lid is raised, the vessel taken away, another similar one put in its place, and the lid lowered again. This should be done once a week only, and never while distillation is going on.

The bisulphide of carbon vapors, now freed from the greater part of uncombined sulphur, pass through a Liebig's condenser, G, about 30 feet long, into a receiver, S, partially filled with water. The cross piece, T, connecting the Liebig's condenser with the receiver, is made so that it can be detached—being secured at *v* by flanges bolted together, and at v^1 by water seal—for purposes of cleaning, etc. From here the bisulphide is allowed to run through a siphon, *p*, direct to the storage tanks. A better plan, however, is to keep the storage tanks for the crude product on a high level, which greatly facilitates the after process of purification. In this case the bisulphide of carbon is allowed to flow into a *montejus*, U, as shown in drawing. A pipe, *q*, reaching nearly to the bottom, is passed through the cover of the *montejus* to the high level tank. A second pipe, *r*, connects the vessel U with a force pump. On air being pumped into U through *r*, the stop cocks p^1 and p^2 having been shut off, the bisulphide is pressed up through pipe *q* into the tank. This is a far better method than using pumps, as in the latter it is difficult to prevent leakage, the crude bisulphide having a very corrosive action on most metals. For the same reason the receivers, tanks, etc., for the crude substance should all be lined with sheet lead, as wrought iron vessels soon perish, while copper is even more energe-

* A paper read before the Society of Chemical Industry.

tically acted upon. Cast iron withstands corrosion much better, but is objectionable on account of its porosity. This might be remedied, however, by giving the vessels repeated coatings of dilute silicate of soda, both inside and outside, the vessels being first slightly heated with steam and the silicate applied while warm.

Near to the top of the receiver, S, is a pipe, *s*, for carrying off the uncondensable vapors—chiefly sulphureted hydrogen. The gases are conducted into a rectangular vessel, W, where they are made to circulate in zigzag over a series of shallow trays filled with a vegetable oil, to absorb any bisulphide vapors which have escaped condensation. The oil can be made to trickle from a reservoir, H, as shown, through a goose-necked pipe, which, passing from tray to tray in an opposite course to that of the gases, finally trickles through X into a receiver, Y. When a sufficient quantity has accumulated here, the bisulphide is distilled off and the oil returned to X. Before the gases enter this absorber they are "washed" by making the end of the pipe *s* dip into the oil, as shown at *y*, whereby the apparatus is disconnected from contact with air. The gases are now passed through a second vessel, Z, similar in construction to the one just described, only substituting lime or oxide of iron for the oil, to absorb the H_2S, and are then allowed to escape into the open air through the pipe *z*.

Above the retort, A, and between it and the chimney, set at right angles to each other, is a smaller retort, similar in construction to A, but only about one-third the capacity of the latter, and is heated by causing the products of combustion coming from the furnace to circulate round it before finally passing into the chimney. (Only the discharge hole, h^1, corresponding to the arm *m* of the retort A, is visible in drawing.) As the generator, A, requires fresh charges of carbon every eight hours, it is very economical to keep this small retort always filled with charcoal, which by the time it is required will be red hot, and no more time need be lost than is required for transferring it from the one into the other retort. By this arrangement part of what would otherwise be waste heat is utilized, and a great saving in time and fuel effected. A still better plan is to make the charcoal on the spot, eight hours being more than sufficient to char the wood and to heat it up to bright redness. The spent dye woods, tanners' refuse, or sawdust are excellent for the purpose, and as these would not require crushing—as when charcoal is bought in lumps—a saving in labor, possibly also in money, might be made, besides being more cleanly. By a small outlay the vapors might be condensed, and pyroligneous acid obtained as a by-product. I have used the sawdust from sandal wood, from which the oil had previously been extracted, for making charcoal in this way, with good results.

The apparatus is worked as follows: After having allowed the brickwork to set and partially dry for a few days, the fires are started, at first gently, to prevent the brickwork from cracking, then gradually increasing the heat until the retort becomes a dull red color. The latter is now filled with small charcoal, and the smaller retort with chips, sawdust, etc., and the fires are now urged on until the retort and the charcoal in it have become a "cherry red." This heat should never be exceeded, nor should it be allowed to fall below this, as in either case it would result in a lesser yield of CS_2. Sidot experimented with specially prepared charcoal at various temperatures, in each case employing 10 grms. of carbon and 40 grms. of sulphur, with the following results:

Temperature.	Loss of Carbon.	CS_2.
	Grm.	Grm.
Dull red heat	5	17
Red heat	6·3	29
Bright red heat	7·5	19

Or for a uniform loss of 5 grms. carbon in each case he obtained 17, 23, and 12·7 grms. of CS_2 respectively. These experiments—borne out by the practical experience of the manufacturer—show conclusively the great importance of maintaining the heat at or about the proper temperature, which is not difficult if intelligent and reliable men are employed.

On having attained the proper temperature, the two openings in the lid of the retort are closed, the lids being screwed down tightly, with some clay made into a thick paste as a lute. I have found it difficult, however, to make good joints in this way, there often being a ring of a pale blue flame round the edge of the lids. A better way would be to cast in the top of these tubulures grooves, and the lids with a rim loosely fitting into these grooves, forming what is called a hydraulic seal, only using lead in the place of water. The heat there is sufficient to melt lead, but not so great as to prevent its use. This would form a much better lute, and could be opened and closed in much less time, which, in the case of bisulphide of carbon manufacture, is a great desideratum. Having previously secured all the joints throughout the apparatus, sulphur is now run in by raising the rod, *o'*, in the sulphur pot. A bubbling will immediately be heard in the gas washer at *y*, caused through the escape of sulphureted hydrogen, etc. In a few minutes this bubbling ceases, and CS_2 begins to distill over. Distillation is now proceeding, sulphur being charged in every five minutes, about 1¼ to 1¾ lb. each time, for seven hours, when the supply of sulphur is stopped, and one hour allowed to elapse before fresh charcoal is filled in. The lid is then removed from G, and the flue pipe, H, lowered. G' may now be opened, and last of all the lid, *h'*, is removed from *h* of the carbonizer, and the red-hot charcoal raked from the carbonizer, by means of a funnel or hopper, into the retort, A. The retort is now closed, taking care that the openings communicating with the flue, H, are the last to be shut off, and work started again. At the end of each week neither coal nor sulphur is charged in for eight hours, after which the whole apparatus is cleaned out in the following manner:

The flue, H, having been lowered on to G, as described above, the cover, *k*, at the end of the delivery pipe, I, is removed, and wet bags or pieces of canvas are tightly rammed down the pipe, I, and past its junction with the vertical pipe, I', so as to isolate the condensers, etc., from the furnace. The ashes are now raked out through M, as described above, the retort refilled with fresh charcoal, and, while this is getting heated up, the other portions of the apparatus are examined, and where sulphur is present it is removed.

With one such retort from four to five cwt. of CS_2 can be made per day, but it is much more economical, both in labor and fuel, to have several retorts—say four—in the same furnace.

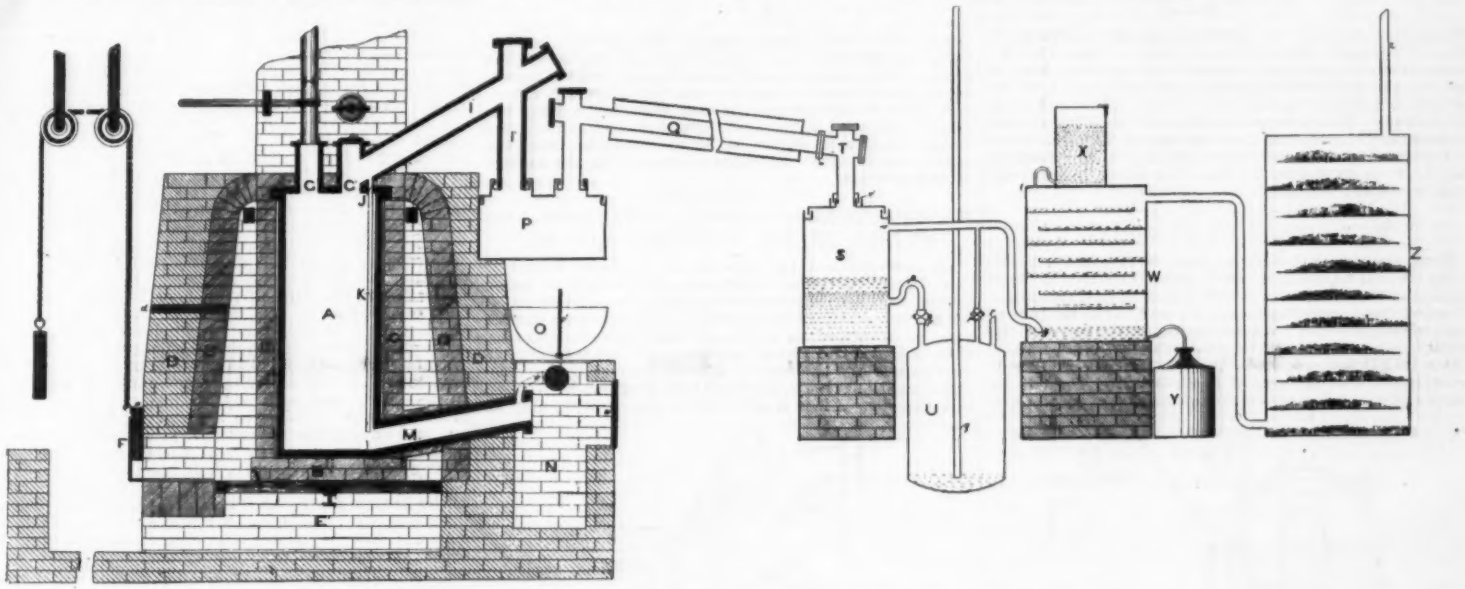


FIG. 2.—MANUFACTURE OF BISULPHIDE OF CARBON.

THE PURIFICATION OF CS_2.

The product obtained by the above process contains considerable quantities of sulphur in solution, also a large amount of H_2S and other sulpho-compounds, which impart to it a pale yellow color and a very disagreeable odor. Of these impurities it can be easily freed by careful rectification, leaving a colorless, mobile liquid, of an odor not at all disagreeable, and resembling that of chloroform. Commercial CS_2 is seldom pure, and in many instances differs from the crude substance only in containing a lesser quantity of free sulphur, while nearly all the other impurities which impart to it that disagreeable smell are still contaminating it. From the latter it cannot be freed by simple distillation, as the H_2S and other gases distill over with it and are reabsorbed during the condensation.

From the many methods that have been suggested for its purification, I shall describe the one only which alone can be employed on the large scale, the others being too expensive for commercial purposes without offering any special advantages.

I have employed the following simple method with very satisfactory results:

A cylindrical vessel, about 30 inches in diameter and 6 feet high, is provided with a perforated coil of lead pipe at the bottom. Into this vessel I run the CS_2 to be purified to about one-third its height. I then pump lime water into it, the latter being introduced into the vessel by means of a force pump through the perforated coil. The lime water, being specifically lighter than the CS_2, rises to the surface, and while traversing the body of the bisulphide in a finely divided spray, the lime combines with the H_2S, etc. I continue this washing until the lime water, which leaves this vessel through an overflow pipe near to the top, is perfectly clear. The CS_2 is now run into a still, about 1 per cent. its weight of a cheap, colorless oil added, and covered with a layer of about one inch of water, to which some sugar of lead may be added. The CS_2 is now distilled in a water bath and condensed in the usual way. A very pure product is obtained in this way. I have treated in this way CS_2 bought from a Manchester maker, which was supposed to be "rectified." Its specific gravity was 1·293; after having washed it in the above manner, it had a specific gravity of 1·289, which was reduced to 1·286 after distillation.

As the various handbooks on chemistry give ample information as regards the properties of this interesting compound, I shall not extend the limits of this paper by describing them, but will conclude by enumerating some of the leading uses to which it is already put. This list is by no means exhaustive, and is rapidly growing.

I. For the extraction of fats and oils from seeds, etc.

II. For the extraction and recovery of oils and fats from bones, stearine waste, dried axle grease, the pressings (greaves) from tallow, sanza (the husks of the olives after leaving the presses), and a large number of other waste products.

III. From rags and cotton waste used for cleaning machinery, leaving both oil and rags in a fit state for reuse.

IV. For cleaning wool and recovering the fat therefrom.

V. As a solvent for chloride of sulphur in vulcanizing caoutchouc and in waterproofing.

VI. For the extraction of sulphur from poor ores, which used to be thrown away as being too expensive to extract by the old process.

VII. For the recovery of grease from soapsuds in wool washing.

VIII. For killing weevils in grain. (A small quantity mixed with the grain in a closed chamber is said to kill even the larvæ.)

IX. In Australia it has been very extensively used for killing rabbits.

X. An emulsion of CS_2 with water, which is easily made by the addition of a small quantity of sulphoricinoleate, is used for killing parasites on plants, and is largely used in France and Germany for the extermination of the *Phylloxera vastatrix*.

XI. In electro-gilding, as a solvent for phosphorus.

XII. In prisms, on account of its great refractive power.

Of late it has been proposed for use in steam boilers instead of water, and several devices have recently been patented for the purpose.

CS_2 is also very useful for producing low temperatures and as an anti-putrescent.

DISCUSSION.

The Chairman remarked that, although Mr. Singer had addressed himself specially to those engaged in this industry, no one could have listened to his graphic account of the process without deriving considerable benefit and pleasure. If Mr. Singer could, in his investigations on bisulphide, discover a practicable method by which such bodies could be eliminated from coal gas, he would confer a great benefit, and especially on the people of that district.

Mr. H. L. Terry had had some experience in the use of carbon bisulphide, and referred to the frequent occurrence in it of sulphureted hydrogen. He had heard that this impurity was produced in the carbon bisulphide on standing, and he wished to know if Mr. Singer had noticed this to be the case. With regard to the explosive properties of this substance when its vapor was mixed with a certain volume of air, he had had convincing proof of this, as during one of the recent fogs a quantity of the vapor collected, and was exploded by a spark, doing serious damage to property. Users of this body were not sufficiently aware of this danger. Nothing had been said as to the deleterious physiological effects of the vapor. His experience was, that if some substitute could be found for it, it would be the better for the health of the workpeople who were brought in contact with it.

Mr. George E. Davis thought there could only be one opinion as to the great technical value of bisulphide of carbon. It showed, perhaps better than anything else, how necessary it was to follow up the process from the beginning. In the erection of chemical plant on a large scale, sufficient consideration was not given to the danger arising from defective construction causing an accumulation, through the apparatus becoming choked, and the necessity of making a hole to admit of an escape.

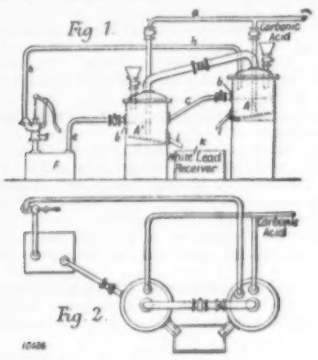
Mr. Watson Smith said that for scrubbing the final gases from the apparatus, coke-packed scrubbers were fixed at the end of the system with which he had worked and filtered anthracene oils were allowed to flow down them. The oil was afterward collected and steamed. Thus, bisulphide of carbon was recovered and sulphureted hydrogen removed in the condensed water. With regard to the methods for preventing the

bisulphide of carbon affecting those who came in contact with it in India rubber works, he thought Mr. I. Frankenburg deserved great credit for covering over the channels conveying the bisulphide and other apparatus with glass, in order to prevent the fumes from affecting his workpeople. A slow draught was thus caused to circulate through the system, so that bisulphide vapors could not escape, though air might be slowly sucked in.

Mr. Singer, in reply, said he would rather use bisulphide of carbon than any other substance. It had the advantage of being heavier than water, and if fairly used, with proper apparatus, nothing was easier to handle.

IMPROVEMENT IN THE PRODUCTION OF WHITE LEAD.

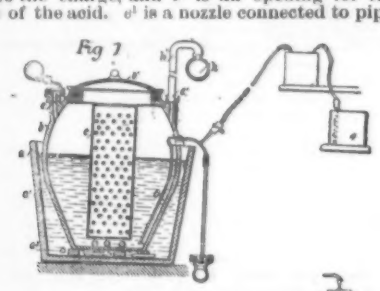
THE apparatus, by R. W. E. MacIvor, London, consists of a vat, A, into which is introduced a solution of acetate of ammonia or other alkaline acetate, and afterward oxide or other compound of lead, which is digested in the solution, with or without heat. Carbonic acid is subsequently introduced by a pipe, *a*, to vat, A.

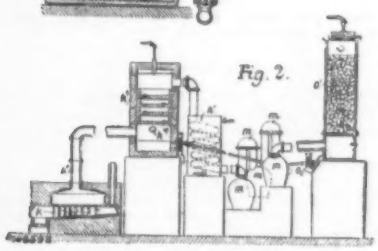


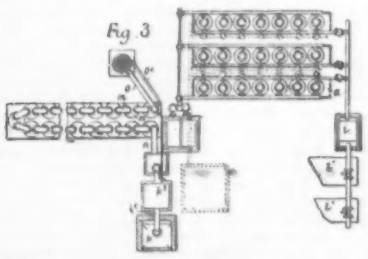
When the mixture is carbonated, the solution is run off through filter, *b*, and pipe, *c*, into vat, A^1, where it acts upon a fresh quantity of oxide of lead in vat, A^1, and passes through filter, b^1, and pipe, *e*, to reservoir, *f*, where it is pumped by pump, *g*, through pipe, *h*, into vat A. This process is continuous, and the acetate of ammonia is used over and over again. The carbonate of lead resulting from this process is run into washing vat, *k*, through shoots, *l*, where it is washed and treated in the usual manner.

PRODUCTION OF CHLORINE.

THIS process is by J. A. Just, Syracuse, N. Y., U. S. A. A still or series of stills are connected in rows termed batteries, each of which is placed in a trough, *a*, of wood lined with sheet lead, a^1, and in the bottom of the troughs is a coil of steam pipes, a^2, for heating the stills. Each still consists of an earthenware jar, *b*, having a gas-tight cover, b^1. The perforated chamber, *c*, receives the charge, and c^3 is an opening for the entrance of the acid. c^1 is a nozzle connected to pipes, h^1





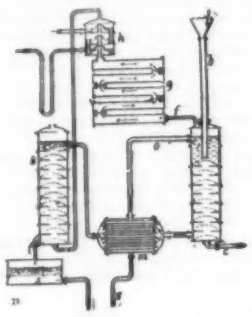


and *h*, for carrying off the gas formed. The main and branch gas main, *h*, into which the chlorine generated is discharged, leads to a washer, *i*, and thence to the chloride of lime chambers, i^2. *k* is a furnace for the recovery of the acid and manganese used. The pipe, k^2, conducts the nitrous vapors to a tower, k^3, through which they rise in zigzag course, a pipe, k^4, admitting air to mingle with them, and at the top a spray of water is admitted which serves to condense the vapors. The vapors and water are carried off to the last jar of the series of condensers, and circulate in the opposite direction to the course of the uncondensed vapors. The uncondensed vapors then pass through a cooler, n^1, to the first of a double row of jars, *m*, from the last of which they are led by a pipe, *o*, to a tower, o^1, where they are condensed, and through a pipe, o^2, again to the last jar of the series. All the manganese dioxide and the nitric acid is recovered and reused indefinitely.

The troughs in which the stills are placed are filled with a strong solution of calcium chloride, heated by the steam pipes, so as to drive from the stills all the chlorine contained in the hydrochloric acid.

MANUFACTURE OF SODIUM BICARBONATE.

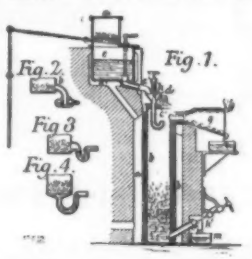
CRUDE bicarbonate of soda dissolved in water, or the mother liquor from previous operations, is clarified by decantation or filtration, and, after being cooled, is treated by carbonic acid. There is a vertical chamber provided with a pipe, *b*, for the introduction of the crude bicarbonate of soda. At the bottom of the chamber is a pipe, *c*, for the admission of steam, and near the top a pipe, *o*, for the admission of water or mother liquor. The gases resulting from the decomposition of the bicarbonate pass through a pipe, *f*, to a cooler, *g*, whence they pass through a washing apparatus, *h*, into a second chamber, *k*, in which the bicarbonate is reproduced. The liquor drawn off from the right hand vertical chamber passes through a filter, and is introduced into a refrigerator, *m*, whence it is conveyed to the top of chamber, *k*, and after being saturated with the carbonic acid therein, the bicarbonate of soda thus produced is drawn off through a filter, *s*, where the pure bicarbonate separates from the mother



liquor, which may be used again. The water or mother liquor is pumped into the refrigerator, *m*, through a pipe, *e*, and passes around tubes through which is conveyed the liquor discharged from the aforesaid chamber. The refrigerator, *m*, is thus used for cooling the liquors obtained in the first operation, and heating the water or mother liquor to be used for dissolving the crude bicarbonate. E. Solvay, Brussels, is the author of this process.

MANUFACTURE OF SODIUM, POTASSIUM, AND METALS OF THE ALKALINE EARTHS.

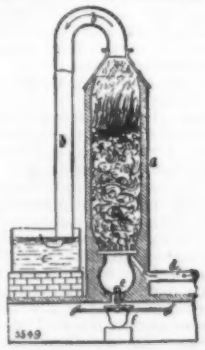
IN carrying out the process, which is by Professor Curt Netto, Dresden, Germany, the retort, *b*, being heated to bright redness by furnace, *a*, is partially filled with charcoal through openings, c^1, and molten caustic soda is admitted in a thin stream upon the glowing charcoal, and the flow of sodium and the metallic sodium appear at the mouth of a condenser, *g*. In commencing, the tube, *k*, is closed by a stopper, k^2, to keep out the air. After a short time the tube, *k*, may be



opened to allow the excess of slag or carbonate to flow out into vessel, *m*. Figs. 2, 3, and 4 show modifications of the device for the discharge of the carbonate. The discharge tube is cast with the retort. The vessel, *e*, contains the molten caustic alkali, and is arranged above a flue, a^1, whereby it is heated sufficiently to melt the caustic alkali, which flows down the passage, e^1, into a hopper, *d*, and thence into the retort, being regulated in its flow by a plug, *h*.

PROCESS FOR OBTAINING ALLOYS OF ALUMINUM, AND PARTICULARLY ALUMINUM BRONZE.

THE process by L. Q. Brin, Auteuil, Paris, consists in the direct employment of salts of alumina or hydrate of alumina, or of bauxite or clay rich in alumina. Copper, iron, or other metal in the form of sheets, lumps, etc., having been cleansed, is coated with a composi-



tion formed of clay, chloride of sodium, borax, and fluorspar, triturated with water to form a paste. *a* is the furnace, charged with coke and metal coated with the flux. The fire being lighted and blast admitted, the metal melts, and the salts of alumina are reduced to metallic aluminum, which combines with the copper or other metal and forms an alloy. The furnace is provided with a chimney, *b*. The escaping gases may be passed into a muffle and utilized in plating metals with aluminum and forming aluminum alloys, or the tube, *b*, may be allowed to dip its mouth just under the surface of water or other fluid in a tank, *c*, wherein the products carried off by the blast will be condensed and retained as by-products. The low temperature at which these alloys melt enables a furnace without a blast to be used for alloying and melting iron and aluminum. *d* is the blast pipe, *e* is the running hole, and *f* a ladle or ingot mould.

THE LAW AND PHOTOGRAPHY.*

By Mr. MORRIS COOPER.

WERE that venerable master of the law, Sir Matthew Hale, still among the blessed living, with what curious feelings would he not receive an invitation to hear a paper read on "The Law and Photography." In the exercise of a wise discretion, he might prefer to remain away altogether; but if he came, you may be sure that he would take a front seat, and woe to the presumptuous meddler who should attempt to erect any new idols in the temple of justice. But the times have changed since one of the noblest and wisest of England's judges thought it fit to preside over witches' trials. The art, which in those days would surely have invited the attention of the courts in a very unpleasant fashion, however, has become the helpmate of the law, and in the service of justice is destined to reach a degree of usefulness limited only by the skill and capacity of the artists themselves.

Until comparatively recent times, recorded history consisted of the doings of soldiers, priests, and politicians; may we not hope, however, that in the history of the future, the man or woman who can relieve his or her fellows from useless drudgery, give them better food to eat, warmer clothes to wear, sweeter surroundings to live in in a word, make this earthly life more human, and therefore more humane, will receive a place at least equally honorable with those whom the world has hitherto been pleased to call its heroes? I venture the opinion that the man, or probably woman, who first used soap and taught others how to use it, conferred as great a benefit on the human race, if not much greater, than the boldest warrior that ever lived, though the latter's deeds may have been sung in a hundred Iliads. A few inventions during the latter end of the preceding and in the early part of the present century, and behold! not only a revolution in the industrial world, but almost a new civilization. The tales of the Arabian Nights are indeed a childish affair compared with the wonderful story of human progress in the present age. It is not my purpose to tell this fascinating story tonight, but in the consideration of the subject before us to emphasize the fact that no one, not even the wildest dreamer, can foretell the uses to which an industrial discovery or invention may eventually be put. It is said that the Bible and Shakespeare have most powerfully affected the Anglo-Saxon race, because they have been so absorbed by that race as to have become a part of its mental habit. Has any one ever reflected how great an influence in the mental make-up of the same race its great mechanical inventions have played? Today, our thinking, living, love-making, marrying, church-going, and even dying, pre-suppose railroads, printing, steam, applied to a thousand forms of industry, and numberless inventions, processes, and discoveries. Simply remember that there was a time when none of these was known, and you can at once see what a part they must have played in the development of the human mind. Not one of the well-known inventions but has introduced a whole series of new problems and new relations, requiring restatement and rearrangement, from time to time. Of the art of photography it may justly be said that its ways are "ways of peace." Unlike most other great arts, it is not applied to the destruction of life or property. Whether its paths are "paths of pleasantness," you, who are so thoroughly familiar with its technical details, are the best judges. To the courts of justice we must look for authoritative expressions upon the questions to which the art has given rise in commerce and society. I propose this evening to discuss some of the problems relating to photography which, in one way or another, have received the attention of the courts.

Let me say at the outset that the law moves with somewhat measured and cautious steps. This is but natural when we remember that the perfection which the law may have attained in any community is simply an index to the development of that community. More accurately speaking, it is a mirror, in which all the intricacies and complexities of society are seen reflected. At the threshold of our investigation, let us consider

THE RIGHT TO PHOTOGRAPH AT ALL.

On this question there is as yet very little judicial opinion. Clearly, every one who sees fit may make pictures of natural scenery. The sky, the ocean, the forests, and the hills are no man's property. So a person could not be prevented from taking pictures of buildings erected upon land, provided he could get his view without going upon private property. There are objects, however, which cannot be photographed without the consent of the owner; that is to say, conceding an abstract right to photograph, a publication of the pictures, or even of the negatives (and a publication would be complete by exhibiting them to a single person other than the one who took them), would be unauthorized. Suppose the rejected suitor of the fair Amanda, by means of a detective camera, succeeds in obtaining a picture of his adored one in the very act of being kissed by his hated rival. Would he be allowed to exhibit such a picture? We think that no photograph exposing others to scorn, disgrace, humiliation, or contempt would be tolerated. The fact that the photograph depicted a scene which actually took place would be no excuse; on the contrary, that very fact would be all the more reason for not countenancing so ungallant a proceeding. Works in which a lawful copyright subsists cannot be photographed without permission. Thus photographs cannot be taken of paintings, drawings, or engravings without consent. An interesting litigation illustrating this phase of the subject arose out of the picture called "The Death of Chatterton." Henry Wallis, the artist of this famous painting, sold it

* Read before the Photographic Section of the American Institute.

to a gentleman who, for a valuable consideration, agreed to sell to one Robert Turner the sole right to make and publish an engraving of the picture, and to exhibit it for short periods at any of the principal towns in Great Britain and Ireland, in order that Turner might obtain subscribers and otherwise derive profit. The picture being thus exhibited by Turner, one James Robinson arranged in his own studio a group which bore an exact resemblance to the picture, and took photographs for the stereoscope, colored them so as to correspond with the picture, and sold them. What did Turner do? Let Robinson have it all his own way and spoil his anticipated profits? Well, not much; he was not constructed that way. He obtained an injunction against Mr. Robinson, and the court sustained him. This brings us to another very interesting query.

Who owns the property in a photographic portrait, the sitter or the photographer? This point has been several times discussed in the public journals, but only once, as far as I can ascertain, in court. One able writer took the view that the property was vested in the artist, and consequently that he could multiply and sell copies at will. Other able writers have combated this notion, and declare that the right to multiply and distribute copies of the picture belongs to the sitter. The only actual decision which I have seen reported was given in the New York *Herald* of January 6, 1889, in the form of an editorial. Here it is: "Mrs. Pollard sat for her photograph at the gallery of the photographic company. Subsequently she learned that the company had prepared copies for Christmas cards, and was offering them for sale. She thereupon applied for an injunction to restrain this liberty. The company contended that the negative was their property, and that they had a right to print copies from it for sale. Mr. Justice North decides that a photographer has no such right unless he is expressly or by clear implication authorized to do so by the sitter. He accordingly granted the injunction. Here are the reasons: The object for which a photographer is employed and paid is to supply his customer with the required number of printed photographs of a given subject. For this purpose the negative is taken by the photographer on glass, and from this negative copies can be printed in much larger numbers than are generally required by the customer. The customer who sits for the negative thus puts the power of reproducing the object in the hands of the photographer, and in my opinion the photographer who uses the negative to produce other copies for his own use without authority is abusing the power confidentially placed in his hands merely for the purpose of supplying the customer. And further, I hold that the bargain between the customer and photographer includes by implication an agreement that the prints taken from the negative are to be appropriated to the use of the customer only."

This decision, it seems to me, expresses the right view upon the subject. A woman's face is her fortune, and why a photographer should without her permission be allowed to distribute her photographs is difficult to understand. The mere fact that the photographer owns the negative, and has in his power the means of doing the injury, no more gives him the right to do so than the fact that a printer who owns the type from which a book has been printed affords the latter the privilege to multiply copies of the book without the author's permission.

Allied to this part of the subject is the question of

COPYRIGHT IN PHOTOGRAPHS.

Under the American statute of 1861, which provided that any person or persons being a citizen or citizens of the United States, or resident therein, who should invent, design, etch, engrave, work, or cause to be engraved, etched, or worked, from his own design, any print or engraving, and the executors, etc., of such persons, should have the sole right of printing, publishing, and vending such print, cut, or engraving, in whole or in part, for the term of twenty-eight years from the time of recording the title thereof, etc., it was decided that no copyright was conferred in photographs, on the ground that photography was not a method of printing within the spirit of the law. In 1865, however, Congress extended the copyright laws to embrace photographs and negatives. Under the present act, the law of July 8, 1870 (U. S. R. S., Sec. 4,952), any citizen of the United States, or residing therein, who is the author, inventor, designer, or proprietor of a photograph or negative thereof, may obtain copyright therein. The term of years for which copyright may be granted is twenty-eight, with a renewal, on complying with certain conditions, of fourteen years more. The matter is in charge of the Librarian of Congress. In a suit brought by Mr. Sarony against a lithographing company for infringement of copyright, one of the questions to be decided was, Has Congress the constitutional power to confer copyright in photographs? The facts were that Mr. Sarony, under an agreement about the month of January, 1882, with Oscar Wilde, made a photograph of that person, which he designated "Oscar Wilde, No. 18." The defendant copied the photographs by means of chromolithography. It was contended in court that a photograph was not a writing nor the production of an author, but the court sustained the power of Congress to give copyright in photographs, making it, however, a criterion that the photograph should be the embodiment of original conception and intellectual production. The claimant, therefore, of a copyright in a photograph under the American law, must, in case his right thereto is disputed, be prepared to show that this work, like that of a successful patentee, is a work of originality, intellectual production, thought, and labor of his own. In the Sarony case it was shown in respect to the photograph in question that it was a useful, new, harmonious, characteristic, and graceful picture, and that plaintiff made the same entirely from his own original mental conception, to which he gave visible form by posing Oscar Wilde in front of the camera, selecting and arranging the costume, draperies, and other various accessories, arranging the subject so as to present graceful outlines, arranging and disposing the light and shade, suggesting and evoking the desired expression, and from such disposition, arrangement, or representations, made entirely by plaintiff, he produced the picture in suit. The plaintiff succeeded in both the lower and higher courts.

An interesting case arose in England in 1883. The English statute allowed copyright to the "author" of an original photograph, for the term of the natural life of such author and seven years after his death. The Australian Cricket Team being in England, the manager of Messrs. Nottage & Kennard, a firm of photgraphers called the London Stereoscopic and Photographic Company, by appointment with the team, directed an assistant to go and photograph them. This the assistant did; thereafter Nottage & Kennard in the usual way prepared and sold the photographs, having previously taken out copyright in their names as proprietors and authors. But the inevitable infringer was abroad. A Mr. Jackson pirated the photographs, and Nottage & Kennard endeavored by injunction to restrain him. This Jackson, however, must have been a good deal like our famous "Old Hickory," of solid and tough fiber. No injunction for him, indeed! He raised the ingenious point that Nottage & Kennard were not and could not be the authors of the photographs. And now the broad foreheads of the English judges were to be wrinkled in wrestling with the knotty problem of who is the author of a photograph. They did wrestle, and this is the result of their wrestling: Jackson bore off the palm. The author, the court held, was the person who took the picture, the person who was most nearly the effective cause of the representation when completed. Justice Field said: "The author of a photograph is the person who most effectively contributed to the result; that is, the person who directed his mind toward and superintended the particular arrangements which have actually resulted in the formation of the pictures, and who that person is, is a question of fact in each particular case." To show how the judges arrived at this judgment, let me quote from the opinion delivered in the case of Brett, Master of the Rolls. He said: "I confess I have the greatest difficulty in construing this act of Parliament. Persons who draw acts of Parliament will sometimes use phrases that nobody else uses. I am speaking for myself only, as to the strangeness of the phraseology; it says 'the author,' and so on, 'of every original painting.' Whoever in ordinary life talks of the author of a painting? We talk of an artist or a painter. Then it says the author of a drawing. One can easily make out who is the author of a painting. The author of a painting is the man who paints it, and the author of a drawing is the man who draws it. Here we have the 'author' of a photograph. I should like to know whether the person who drew this act of Parliament was clear in his mind as to who can be the author of a photograph. We understand that all the photographers have come to the conclusion that they are the authors of a photograph; that is, the people who own the machinery, the people who keep the shop, the people who pay the servants; that they are the only persons who are interested in the photograph at the time it is done; they think they are the authors of the photograph because the photograph is made and formed by the work of their mere servants. I cannot tell whether the person who drew this act of Parliament had that idea or not; but I am not satisfied in my mind that he had, because it is full of difficulties. Here you have merely two gentlemen stated to be the authors. Can two people be the authors of a photograph? It is difficult to say; but if they are, for whose life is it to last—for the life of one of them, or for the life of the longer liver, or what? They are the owners of everything about the place, the machinery and everything else, but they may live in Scotland and their photographic shop may be carried on in London. They may live two hundred miles off—can they be called the authors of a photograph of which they know nothing? It is done by their servants; they may go to the shop once a week, and when they are there, they may superintend the operations, though they seldom do, I suppose. At all events, they cannot superintend the taking of all the photographs in their shop. They may have half a dozen studios; they may superintend the taking of a photograph in one place, and they may have a skilled person who superintends the taking of photographs in another place. It would be obvious that they are the authors of a photograph where they are, but are they the authors of a photograph where they are not? Take this very case: It is not pretended that these gentlemen were at the place where the photograph was taken. They were either in London, or fifty miles, perhaps, the other side of London. They send a man to the place. The idea of photographing the Australian cricketers may have been the idea of one of these gentlemen, and he, if he saw the other, may have put it into the head of that other. The man who went was the man who took the photograph. What had he to do? He had to arrange the group, to put them in the right position and the right focus. But he does not do it all, because there is another man who gets the plate ready, I suppose; and there is another man who, when the thing is ready, takes the cap off. Neither of them forms the picture, because, after all, that is done by the sun. As I say, I wonder whether the gentleman who drew this act of Parliament was clear in his own mind. I do not think he was, and confess I cannot myself be very clear about it. All I can do is to see who is the person who most nearly answers the description of the other things, or the author of a painting, or the author of a drawing. All I can say is, it is not the man who simply had the idea of a picture, because the proprietor may say, 'You go and draw Mrs. So-and-so, with a dog at her feet, and holding a flower in one hand.' He may be two miles away from the place, and he may have given the instructions by letter. The nearest I can come to it is that it is the person who effectively is as near as he can be the cause of the picture which is produced—that is, the person who has superintended the arrangement, who has actually formed the picture by putting the people into position, and arranging the place in which the people are to be. Although he may only have done it by standing in the room and giving orders about it, still it is his mind and action, so far as anybody's mind and action are concerned, which are the effective cause of the picture, such as it is, when it is produced. Therefore, it will be a question in every case who that man is. That would be a question of evidence. That would be what my learned brother would call a question of fact. We have not to say in this case who was that man. I suppose it was the principal who was sent down to the place. At all events, it was neither of these two gentlemen who are described as authors, and it was certainly not both of them. Therefore, the author here is wrongly described, and the registration is bad and the copyright does not exist."

It is appropriate here to speak of

THE CONTRACT TO PHOTOGRAPH.

What does the photographer undertake to do when he engages to supply photographs? Does he contract to furnish artistic, pleasing, beautiful pictures or accurate and faithful likenesses? I would not for a moment be understood as saying that the idea of the one excludes the other. But the point is, what does the customer expect, and what is he entitled to receive? It seems to me that the customer has a right to expect a good likeness, finished in as artistic a manner as the contract calls for. But this opens the door to a sea of controversy. What is a good likeness? Perhaps the sitter belongs to that unfortunate class in the community who cannot show you the family album without remarking that "they really never take a good picture, but that So-and-so always does." And then there are one's friends, cousins, and aunts, whose opinion is of vital importance on the subject. A certain Mrs. Pearson, of London, was sued for the price of some photographs she had ordered. The photographer admitted that the negative had been touched up, but alleged that it was necessary in order to make customers look their best. The judge thought the photographs made the lady look younger than she appeared to be, but she, strange to say, protested against a flattering likeness. She wanted it perfectly natural. The case was submitted to the jury, and they, probably unable to comprehend so unusual a defense, brought in a verdict against her. Whether a painting or photograph is executed in the most artistic manner possible, only an artist or photographer can tell; but ordinary witnesses, the courts have held, are competent to say whether a photograph is a good likeness. In short, whether a photograph is a good likeness or not, will have to depend upon the particular jury before whom the picture is exhibited. As to the price of pictures, it has been held that if no special contract is made fixing his compensation, the artist is entitled to such pay as, taking all the circumstances together, his work is reasonably worth. The market price of such work would have to be determined from the evidence of photographers doing the same class of work. But a very important circumstance to be considered on such an inquiry is, not only the real standing of such artist, but also his apparent worth as shown by his appearance, surroundings, and general bearing. A case illustrative of this point recently arose in Michigan. The plaintiff was an artist, and from photographs, painted pictures of defendant's children. No agreement seems to have been made fixing the price for the work. The plaintiff demanded that the court should recognize as an element of his charges the expense and preparation necessary to make a first-class artist, but the court did not see things just that way. It decided that if a man has really become eminent in his profession, and has a recognized standing, his compensation may by a customer be fairly presumed to be in the line of what eminent artists charge, but an obscure and unknown artist, getting a job for perhaps the first time, cannot demand from the customer so great a fee, for the reason that the customer has a right to expect that the charges will be in keeping with the artist's surroundings and general appearance. I confess that I am not in sympathy with this decision. I believe that it holds up a wrong standard. It seems to me that the principle which deems every laborer worthy of his hire is as applicable to art as to any other kind of work. A man should be paid for what he can and does do, and not for what he seems to be able to do. For improper and immoral pictures no compensation could be recovered. And this brings me to consider

IMMORAL AND OBSCENE PHOTOGRAPHS.

The manufacture and circulation of these is not only culpable legally, but is equally odious and detestable from the standpoint of true art. It is sometimes said that, in reference to this subject, the law is too straitlaced and prudish; but that this is not so, and that sound and sensible views are entertained by the judges before whom such matters have come for consideration, I shall endeavor to show by reference to a case recently decided in our own Court of Appeals. A man whose name need not be mentioned was convicted under our Penal Code for selling obscene and indecent photographs. It appeared that the photographs represented nude females, and were photographic paintings which had been exhibited in the Salon in Paris and one of them at the Centennial Exhibition in Philadelphia. It was decided that it was immaterial whether the pictures had been exhibited in these galleries or not. Now follow carefully the reasoning of the court. Judge Andrews, an exceedingly clear-headed judge, said: "It is to be observed that the statute does not undertake to define obscene or indecent pictures or publications. But the words in the statute are themselves descriptive. They are words in common use, and every person of ordinary intelligence understands their meaning, and readily and in most cases accurately applies them to any object or thing brought to his attention which involves a judgment as to the quality indicated. It does not require an expert in art or literature to determine whether a picture is obscene or whether printed words are offensive to decency and good morals.

"These are matters which fall within the range of ordinary intelligence, and a jury does not require to be informed by an expert before pronouncing upon them.

"It is evident that mere nudity in painting or sculpture is not obscenity. Some of the greatest works in painting and sculpture, as all know, represent nude human forms. It is a false delicacy and mere prudery which would condemn and banish from sight all such objects as obscene, simply on account of their nudity. If the test of obscenity or indecency in a picture or statue is its capability of suggesting impure thoughts, then, indeed, all such representations might be considered as indecent or obscene. . . . The test of an obscene book was stated in Reg. v. Hicklin, L. R. 3 Q. B. 369, to be whether the tendency of the matter charged as obscenity is to deprave or corrupt those whose minds are open to such immoral influences, and who might come in contact with it. We think it would also be a proper test of obscenity in a painting or statue whether the motive of the painting or statue, so to speak, as indicated by it, is pure or impure; whether it is naturally calculated to excite in a spectator impure imagination, and whether the other incidents and qualities, however attractive, were merely accessory to this as the primary or main purposes of the representation." I think the language of the court in

this case is in harmony with the views of the majority of cultivated people on the subject.

PHOTOGRAPHS AS EVIDENCE IN COURTS OF JUSTICE.

The photograph is beginning to play an important role in judicial proceedings. It is a species of what is called secondary evidence. That is to say, it is to be resorted to in explanation and support of other evidence, or when no other evidence is available. It has been introduced in both civil and criminal trials. I shall cite a few typical cases. In the Buddensieck case, which, as you remember, was a prosecution for manslaughter caused by the falling of a building negligently constructed, a photograph of the premises showing the defective construction was used and exerted great influence in securing a conviction. In the celebrated Ruloff murder trial, an important link in the chain of evidence against the accused was forged by means of photographs which identified his confederates. On the trial of the Shepherd's Fold case, which was a prosecution for starving and ill-treating a boy who was an inmate of the "Fold," photographs of the boy, showing the effect of the "Shepherd's" shepherding, landed the shepherd into the penitentiary.

An Iowa case presents some curious features. It was an action for damages for assault and battery. On the trial, which took place nearly two years after the assault, the defendant exhibited to the jury the plaintiff's back and shoulders, which of course, after that lapse of time since the injury, could not exhibit any very great marks thereof. But the plaintiff, not to be outdone, then triumphantly exhibited photographs of the same back and shoulders taken three days after the assault. This must have been a case of diamond cut diamond. The plaintiff, however, was a sharper diamond, and was victorious in the suit. There is also the case of a Canadian lady whose husband was lynched in Alabama by a mob. He had sent her a photograph of himself, taken shortly after his arrival in that State. She brought a suit against the county where the little "accident" occurred, for damages for the loss of her husband's life; and her whole case, which I am glad to say she won, depended upon the photograph, for her husband had been a stranger in the community, and by means of the likeness he was identified. In suits growing out of defects in highways, railroad accidents, forgery of commercial paper, disputed signatures, photographs have become valuable aids. But it must not be supposed that every photograph is received with open arms in a court of justice. The liability of photographers to err, to present partial, inaccurate, distorted, and even downright dishonest views, is well known to the courts and has often been commented on. In the Tichborne case, a photographer represented a place as a *grotto* which in reality was nothing else than a path about a hundred feet long, shadowed by trees, having a public way on one side and a public towing path upon the other. The Lord Chief Justice (Cockburn) presiding at the trial handled it without gloves. He said: "I must add that it reflects the greatest discredit on the man who concocted that photograph." That is not with any disparagement to the art itself, for in the same case the art of photography rendered most valuable help. "The principal documents in the case," says the *London Times*, "the pocket-book of the defendant, his letters and those of Roger Tichborne, were photographed by the Stereoscopic Company, under the auspices of Mr. Nottage, their manager, and the *fac-similes* thus produced were of immense value in facilitating the comparison of handwriting, to which the lord chief justice attached much importance as one of the great tests of identity." A very valuable aid which the photograph is enabled to render in courts is to make copies of documents which, from their value, inaccessibility, or other peculiar features, cannot be produced in court. In several such cases the courts have directed the making of photographic copies.

It must be borne in mind, from the considerations to which we have before alluded, that photographs are very carefully scrutinized in courts of justice, and that the party desiring to use them must always be prepared fully to show all the circumstances under which they were taken—who the artist was, with what apparatus, in what light, from what point of view, at what distance, at what angle; in fact, must be prepared with all the details. He should also produce the negative, so that that also can be subjected to rigid examination. Not until a photograph is "proved," as it is termed, is it competent to be admitted in evidence.

LEGAL USES OF PHOTOGRAPHY.

There have been numerous applications of photography to the purposes of justice. The rogues' gallery is familiar to you all—not in any invidious sense, of course. Some suggestions which are of value, and some which are not, have from time to time been made respecting further applications of the art. One ingenious gentleman has invented an apparatus for recording deeds by photography. One has suggested that by photographing the impressions made upon the retina of the eyes of a murdered person, a possible clew might be obtained as to who the murderer was. Another proposition is to appoint a public photographer, whose duty it should be to take and preserve the likeness of all persons residing in England every five years, and also likenesses of all persons leaving the country. This is what, in politics, would be called a "fat" job. So it has been proposed that naturalized persons should have photographs of themselves attached to their papers, certified by an omniscient individual to be styled the "official photographer." Another idea is to photograph the witnesses deposing in trials, so that the pictures will be before the appellate court when it passes upon their testimony, and it could then see the witnesses both in tranquil and in excited moods. Still another proposition is to photograph riotous assemblies at various stages, and then subsequently prosecute the persons taking part. The difficulty, however, about this is that there is a very decided danger that the photographer and his apparatus might, perhaps, perish in the riot long before he succeeded in getting a focus. The most practicable suggestion of this kind which I have met with is one to appoint a public photographer who, in all cases of homicide, shall immediately repair to the scene of the crime and photograph it and the body. In this way very valuable evidence might be elicited. For the other suggestions and plans I do not think that legal machinery is at yet sufficiently advanced.

January 16, 1889.

ALTERNATIVE DESIGNS FOR FIRST CLASS BATTLE SHIPS.*

ON August 17, 1888, a special meeting of the Board of Admiralty took place at Devonport—during the annual inspection of the yard—for the purpose of discussing the principal features to be embodied in the designs of first class battle ships proposed to be laid down in 1889–90. The members of the board had before them the particulars of the designs of the most recent battle ships constructed, or in course of construction, for the Royal Navy and for foreign navies, and passed in review the systems of armament and protection embodied in various types. The questions of speed, coal endurance, freeboard, principal and secondary armament, armor protection, etc., were all separately considered, and a provisional decision arrived at for the guidance of the director of naval construction in preparing alternative outline designs to be subsequently submitted to the board.

After contrasting and comparing the various dispositions of armament illustrated in different types of battle ships, it was unanimously agreed that the following principles should be complied with in disposing the armament of the new battle ships: (1) That there should be four heavy guns placed in two protected stations situated at a considerable distance apart, each pair of guns having an arc of training of about 200 deg., equally divided on each side of the line of keel. All four of these guns are to be available on each broadside. (2) That the greater portion of the auxiliary—or secondary—armament should be placed in a long central battery situated between the two heavy gun stations, and so disposed that there should be practically no interference with the fire of any one gun by that of any other. (3) That in view of the development of high explosives it was desirable to secure the widest possible distribution of the guns in the auxiliary armament, and that it was preferable to mount the auxiliary armament on two decks, one of them being the spar deck, rather than to carry the guns chiefly between decks. The best modes of protecting the guns and guns' crews in the auxiliary armament were debated, but a final decision was reserved until the experiments intended to be carried out in the Resistance had been completed.

This disposition of the armament was not decided upon without careful comparison of its advantages and disadvantages with those of other systems; for example, the system exemplified in the Imperieuse and Warspite, and in many foreign ships where the protected stations are multiplied and each contains one heavy gun. The isolation of single heavy guns was seen to have some advantages; but experience in the Warspite and Imperieuse had shown that with this disposition of the heavy guns there must be a considerable interference with the efficiency and power of independent action of the auxiliary armament; and to protect these four separate positions necessarily required the expenditure of a very much greater weight of armor for a given thickness than was involved in the construction of two stations, each containing two guns. Other plans for carrying the heavy guns in positions where their comparative concentration would enable a reduced area of protective armor to suffice, also came under review. Many illustrations of the general idea of concentrated heavy armaments were considered, including "central citadels" with the heavy guns carried in turrets or barbettes, and placed either abreast one another or *en echelon*, central batteries with broadside armaments, or citadels placed high above water and isolated from the hull armor.

It was considered that the objections to all these plans were too serious to permit of their adoption, and that these objections might be grouped under two principal heads, viz.: (1) The great risk of the principal armaments being placed *hors de combat* by the explosion of a single heavy shell within or under the armored inclosure; (2) the enormous difficulties which this disposition of the main armament introduced into the efficient working of a powerful and numerous auxiliary armament. It was also noted before recording the decision above mentioned, that in some of the most important foreign navies, where one or other of these modes of disposing the armament had been adopted, and the principles either of extreme distribution or of relative concentration had been carried out, the latest designs had contained arrangements similar to those decided upon as best for future battle ships in the Royal Navy, which disposition is also to be found represented—in plan—in vessels like the Trafalgar and in the Admiral class.

This decision of the board respecting the best disposition of the armament necessarily exercised a preponderating influence upon the preparation of all the designs in which it should be embodied. But it left open the question of the extent and character of the protection to be given to the ships by means of vertical and deck armor, as well as the protection of the armament, and the adoption of the turret or barbette systems. It was desired to base a decision on these features upon the consideration of alternative designs for ships of about the same size and cost, which should provide for either the barbette or the turret system of mounting the heavy guns, and for moderate or high freeboard at the extremities. After full consideration, the board came to the conclusion that each first class battle ship should carry four 13½ in. 67 ton breech-loading guns as the principal armament, thus corresponding to that carried by the Trafalgar and other recent battle ships. Further, that the auxiliary armament should include ten 6 in. guns—preferably of the quick-firing type—and a considerable number of 3-pounder or 6-pounder quick-firing and machine guns. It was provisionally decided also that the length of the armor belt in the region of the water line in the new ships should bear the same ratio to the total length of the ship as in the Trafalgar.

On these and other instructions received subsequently

Fig 1.

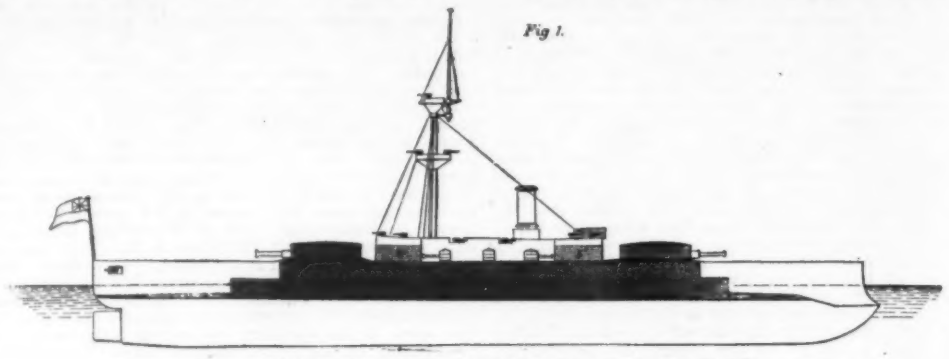


FIG. 1.—TURRET SHIP (CITADEL), TRAFALGAR TYPE.

Fig 2.

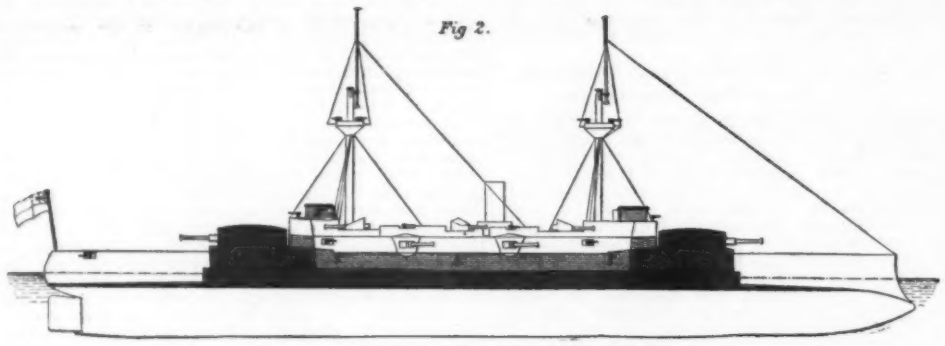


FIG. 2.—TURRET SHIP WITH REDOUBTS.

Fig 3.

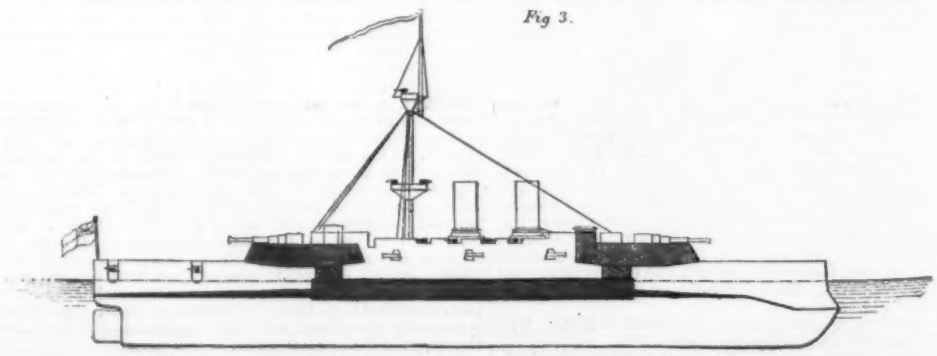


FIG. 3.—BARBETTE SHIP, ADMIRAL TYPE.

* Parliamentary paper, from the *Engineer*.

from the board as to details, a considerable number of outline designs were prepared, for both turret and barbette ships; and detailed particulars of relative sizes and costs were placed before the board. In the interests of the public service it is not desirable that this detailed information should be made public, but the following brief summary and illustrative diagrams will make clear the principal features in the designs from among which a selection was eventually made.

For convenience these may be arranged in two groups, viz., the turret ships and the barbette ships. The Trafalgar was taken as the typical turret ship with which to compare the other designs. The principal particulars of the Trafalgar, as designed, are given in column 1 of the tabular statement herewith, and the general disposition of the armor and armament are illustrated in Fig. 1. It must be stated that, while the particulars given in the table are for the Trafalgar as designed, the completed ship will probably be about 10 in. in excess of the designed draught, and about 500 tons in excess of her designed displacement, various additions having been made to the armor and armament, etc., during her construction. Furthermore, in the case of the Trafalgar, the nominal load displacement, as designed, does not include the board margin of 4 per cent. which now has to be provided in all new designs, and which, in her case, would involve a further addition of about 10 in. to the draught if she were being redesigned. In other words, if a simple repeat of the Trafalgar were now ordered, it would be necessary to considerably increase the length, and with it to lengthen the belt of armor, in order that the necessary displacement might be provided within the limits of draught accepted in the original design; provision being made at the same time for the board margin of 4 per cent. on the displacement. In all the alternative designs for turret ships put before the board, the mean draught of 27½ ft. has been treated as a maximum, the freeboard has been kept the same as in the Trafalgar, the height of the turret guns above water has been increased about 2 ft., and the more powerful auxiliary armament has been embodied, being accommodated in a longer central battery than exists in the Trafalgar. In all these designs the water line has been protected by a belt of armor extending for about two-thirds the length of the ship, the depth of the armor below water being 5½ ft. and the height of the belt above water 3 ft.

Two alternative arrangements have been considered for the protection of the turret bases and loading apparatus. In the first the turrets stand at the end of a long armored citadel, extending to the full breadth of the ship, and with vertical armor on the sides rising to a height of about 11 ft. above water. The upper deck over this citadel is protected by 3 in. steel. In the alternative arrangement the 3 in. steel deck is placed at the height of the top of the belt armor, and each turrets placed in a separate lozenge-shaped redoubt, strongly armored, and inclosing not merely the turret bases, but also the upper portion of the ammunition hoists and the loading appliances. The broadside of the ship in this case is protected from the top of the belt to a height of about 10 ft. above water by vertical armor 5 in. thick, extending over practically the same length as the citadel extends in the other plan, and the ends of the space so protected are closed in by armored screen bulkheads extending to the height of the spar deck. The first arrangement is sufficiently illustrated by Fig. 1 for the Trafalgar. The second is illustrated on Fig. 2, which shows the principal features of the disposition of the armor in a turret ship with separate redoubts and thin side armor above the belt. As a matter of information the particulars of two designs, one armored on the citadel plan, and the other with separate redoubts, are given in columns 2 and 3 of the tabular statement herewith. These two ships, it will be observed, are identical in dimensions, in water line protection, armament, engine power, speed, and coal supply. In the one case, with a continuous citadel, the armor on the turret is 15 in., and that on the citadel sides 14 in. and 12 in., whereas in the ship with separate redoubts the armor on the turret is 18 in., and that on the redoubts 17 in.; the broadside armor is 5 in. thick above the belt. It will be seen, therefore, that the adoption of the redoubt system, when it is associated with a long central battery, containing the powerful auxiliary armament provisionally decided upon, enables a very appreciable increase to be made in the defense of the turret bases, the turret guns, and of all the loaded appliances, as compared with what is possible when the continuous citadel is adopted.

Particulars of Outline Designs for First-class Battleships.

	1 Trafalgar (as designed).	2 Citadel turret ship.	3 Redoubt turret ship (design C).	4 Redoubt turret ship.	5 Barbette ship, Admiral type, (completed).	6 Barbette ship (design c).	7 Barbette ship.
Length .. .. feet	345	380	380	350	330	380	350
Breadth .. .. "	73	75	75	70	68½	75	70
Draught (mean) .. .. "	27½	27½	27½	27	27-10	27½	27½
Displacement (approximate) .. .. .. tons	12,000	14,000	14,000	12,000	10,350	14,000	12,000
Freeboard, forward and aft .. .. .. feet	11½	11½	11½	11½	10½	18	18
Heavy guns above water .. .. "	15	17	17	17	20	23	23
Horse-power, forced draught	12,000	13,000	13,000	12,000	11,000	13,000	12,000
Speed, forced draught .. .. .. knots	16½	17	17	17	16½	17	17
Speed, natural draught .. .. .. "	15	15	15	15	15	15	15
Coal carried .. .. tons	900	900	900	900	900	900	900
Armament, main	4 67 ton B.L.	4 67 ton B.L.	4 67 ton B.L.	4 45 ton B.L.	4 67 ton B.L.	4 67 ton B.L.	4 45 ton B.L.
auxiliary	8 5in. B.L. 8 6-prs. 10 3-prs.	10 6in. Q.F. 10 6-prs. 8 3-prs.	10 6in. Q.F. 10 6-prs. 8 3-prs.	10 6in. Q.F. 10 6-prs. 8 3-prs.	6 6in. B.L. 12 6-prs. 7 3-prs.	10 6in. Q.F. 10 6-prs. 8 3-prs.	10 6in. Q.F. 10 6-prs. 8 3-prs.
Length of belt .. .. feet	230	250	250	230	150	230	230
Armour, belt .. .. inches	20 to 14	18 to 14	18 to 14	14	18	18 to 14	14
turrets .. .. "	18	15	18	13	—	—	—
citadel, redoubts, or barbettes "	15	14	17	13	14	17	13
side between bases of barbettes or turrets .. .. "	16	12	5	4	Unprotected.	5	4
armour tube, or base of barbettes .. .. "	—	—	—	—	12	17	13
conning tower .. .. .. "	14	14	14	14	12	14	14
auxiliary armament	Unprotected.	Protected.	Protected.	Protected.	Unprotected.	Protected.	Protected.

however, to reproduce these particulars, as it was decided that it would be undesirable to incur the extra expense and increase of size involved in securing these variations from the design of the Trafalgar.

Furthermore, an investigation was made as to what could be done on a displacement of about 12,000 tons, inclusive of the board margin of four per cent., if the same freeboard, speed, and coal endurance were accepted as were designed for the Trafalgar, the same proportionate length of armor belt adopted, and the auxiliary armament kept identical with that in all the other designs. The results are shown in column 4 of the tabular statement, and as there given they correspond to a double turret ship with each turret placed in a separate redoubt. For purposes of comparison with the turret ship designs, a series of designs were also prepared for several barbette ships, in which should be embodied the following features: Greater height of freeboard at the ends, four heavy guns placed high above water in two separate barbettes, and a central battery containing an auxiliary armament identical with that provided for in the turret ships. These designs differed from the preceding barbette ships of the Admiral class in two essential features, which will be sufficiently understood by reference to Figs. 3 and 4. Fig. 3 shows the disposition of the barbettes in the Anson. It will be seen that the armored barbettes are carried at a considerable height above the armored portion of the hull, the connection for the ammunition hoists and passages being protected by armored tubes. In these features the Admiral class resembles the barbette ships in foreign navies, but in strength of the protective armor on the tubes, and in the general protection of the loading arrangements and gun mountings, the English type of barbette is far superior to that to be found in most foreign war ships. It was decided, however, in view of the great development of high explosives, that in any new designs for barbette ships the proportion of the length at the water line protected by the belt of armor should be greater than the corresponding proportion in the Admiral class, and, further, that the armored barbette towers should be carried down to the top of the belt in order that there should be no possibility of the bursting of shells containing large explosive charges under the floors of the barbette upon which the revolving gun platforms are carried. This feature is illustrated in Fig. 4.

The second point of difference, as compared with the Admiral class, is to be found in the increased freeboard at the extremities. It was decided that in the barbette designs the broadside, from the top of the belt armor to a height of about ten feet above water, should be protected by armor of moderate thickness, as in the redoubt turret ship, illustrated by Fig. 2. The series of designs for barbette ships was practically co-extensive with that for the turret ships. In order that a definite comparison might be made, each design for a turret ship was associated with a design for a barbette ship of identical external dimensions and draught, the same displacement, the same coal endurance and armament, the same extent and character of armored protection at the water line belt and on the broadside, and the same thickness of protective deck.

Fig 4

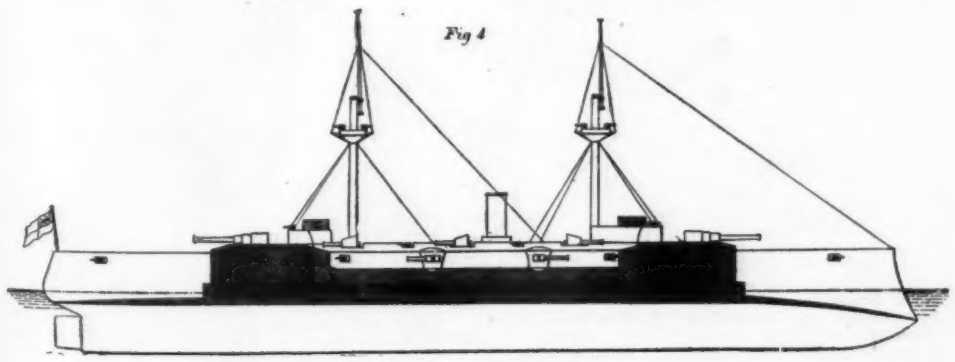


FIG. 4.—BARBETTE SHIP.

It should be explained that in both cases the defense afforded by the side armor fitted above the belt will be re-enforced by continuous coal bunkers, which, when filled, will contribute to the defense, and when empty will form cellular compartments in the rear of the armor. Keeping to the main features illustrated in the two designs, thus briefly described, investigations were made also to determine what additional cost would be involved in adding to the speed and coal endurance as designed for the Trafalgar; and particulars of the approximate dimensions and cost of two turret ships having a natural draught speed of seventeen knots, a coal endurance about thirty per cent. greater than that of the Trafalgar, and similar belt protection, were placed before the board for consideration. It is unnecessary, the most careful consideration in relation to all the designs, whether for turret or barbette ships, was the protection proper to be given to the guns in the auxiliary armament, in view of the development of high explosives and quick-firing guns of large caliber. On this matter a provisional decision was reached, and experiments were arranged which are now about to be completed in the Resistance. But pending the completion of these trials and their analysis, it is undesirable to make public any particulars of the methods likely to be adopted. It will be sufficient to say that a liberal allowance of weight has been made for the protection of the guns in the auxiliary armament and of the gun's crews, as well as for rapid transport of the ammunition and its protection in all the stages of its passage from the magazines to the guns.

In the tabular statement herewith are given the particulars, in columns 6 and 7, of two of these barbette designs, as well as the corresponding particulars for the Anson as built. The two new barbette designs will be seen to correspond respectively in dimensions, displacement, etc., with the two turret ship designs, for which particulars are given in columns 3 and 4. It was furthermore arranged that in each case the cost of the barbette ships and of the turret ships should be practically identical. It will be seen that the heavy guns in the barbette ships are carried six feet higher above water than in the turret ships, and that the height of freeboard forward and aft in the barbette ships is eighteen feet, as against about eleven and one-quarter feet in the turret ships. One point which received

THE TUNNELING OF SELEUCIA, SYRIA.

HAVING decided on fortifying this important locality, Seleucus required a port for the protection of his ships; and he knew that a harbor without a backwater to cleanse it would speedily fill up. He conceived the idea, therefore, of forming a culvert, which served the double purpose of carrying off the accumulated waters from the mountain and of clearing either the outer or inner port, as occasion required, by, as we suppose, sluice gates of some kind or other. He then built up a strong wall between the upper tunnel and the cliffs which crown the hill on which the ancient village stood; thus effectually closing the entrance to the glen or basin in which the waters collected. But he left an opening in the center, which communicated with a strong conduit, by means of which, and by suitable sluice gates, he could, at pleasure, direct the whole of the water into the inner harbor or into the culvert to the outer port. This wall still exists; it is built of large stones, and is in good preservation.

Of course the sluice gates are gone, and there is an open gap through which the waters pass as formerly; and the conduit which supplied the backwater being defective, the hill is more or less flooded, as already stated. About fifty yards from the western extremity of the great wall, the first or upper tunnel begins. It is 142 yards long, 21 feet high, and 21 feet wide; and there is a central channel of from 3 to 4 feet in depth and width. The conduit on the left side, before mentioned, is so situated as to insure an abundant supply of water, and it passes along both tunnels and the intervening cutting, as far as the staircase and bridge, where in consequence of the fall of the culvert it meets the surface of the hill, and was thus made to supply the town with water.

The cutting between the tunnels is 88 yards long, open at the top; and according to Captain Allen's survey, a vertical section of it at the upper end measures 150 feet, and it gradually declines to 75 feet, where the second tunnel commences. The culvert, viewed as a work of art, raises the ancients greatly in our estimation; and, if proof were wanting, shows them to have been a people of no ordinary capacity. It would be considered a great undertaking even in the present day, with all our experience in engineering, our scientific attainments, and appliances of gunpowder, steam, and machinery. What a work of labor it must have been then, at that early period, to excavate a passage of such magnitude through hard limestone rock for a distance of three-quarters of a mile; indeed, including all the outworks or appendages, we may fairly say a good English mile. Both the tunnels and cuttings are exquisitely contrived and shaped. They could not be better done by any of our modern engineers; there is no denying the fact—scientific men who have seen it allow it; and yet this magnificent triumph of human ingenuity is scarcely known to the world, and no use is made of it.—*W. H. Yates.*

LIGHT REFLECTED FROM MAGNETS.

AT a recent meeting of the Physical Society, Berlin, Prof. Kundt gave a short *resume* of the researches which he had been carrying on of late years on the behavior of metals to light. He took as his starting point Kern's discovery that light which is reflected from magnets undergoes a rotation of the plane of polarization, and fully confirmed this as well as all subsequent observations of the English experimenter. In order to avoid any objections which might be raised against the accuracy of the observed phenomenon, he investigated the rotation produced by extremely thin films of metal, whose production was found, after several preliminary experiments, to be most easily attained by pulverizing the kathode *in vacuo*. The light which was transmitted showed signs of rotation, and as a result of a full experimental investigation all metals were found to exert a dextro-rotatory action on light. This law of the positive rotation of the plane of polarized light could be extended to all simple bodies. The thin metallic films further exhibited a doubly-refractive action which led him to determine the refractive index of the metals, after he had succeeded by means of electrolysis in preparing transparent metallic prisms. The speaker described the methods which he employed in these ex-

periments, and exhibited the apparatus which he had used.

The result of the experiments is already known. The metals possess a varying refractive power, some exhibiting normal, others abnormal, dispersion. The velocity of light in the several metals followed exactly the same serial order as that of their respective conducting powers for electricity and heat. Since it was possible that the deviation of the rays while passing through the metals did not depend upon a true refraction, the speaker had recently examined the behavior of the refractive indices of the metals at different temperatures. Metals whose refractive index is large showed an increase of the angle of deviation of light as the temperature rises, and thus all doubt as to the fact that he was here dealing with a true refraction was set aside. A further outcome of these experiments was to show that the velocity of light in metals is dependent on changes of temperature in a way exactly similar to that in which their electrical conductivity is dependent. In order to determine accurately the relationship of the velocity of light to their conductivity, these two values must be measured on one and the same piece of metal. When determining the electrical conductivity in films of metal as thin as those he was using for his optical researches, he found that the greatest difficulty was presented by the measurement of the thickness of the film. In his earlier researches, local thicknesses of 0·11 to 0·14 millionth of a millimeter were measured—values which approximate to the diameter of a molecule. These measurements, the preparation of transparent metallic prisms, and a number of other questions which have become prominent in the course of the above researches, partly carried out by pupils of the speaker, he intends to pursue further.

THE MECONIUM OF BUTTERFLIES.

M. THEODORE GOOSSENS communicated a notice to the Société Entomologique de France, April 11, 1888, on the above subject. We translate the notice in full from the *Bulletin entomologique* of that society.

"If the rearing of larvæ affords gratification in studying, as far as possible, their habits, it sometimes gives one bitter disappointments. Sometimes all the caterpillars, almost full grown, die at once without a trace of diarrhea or of fungi, that is to say, of other causes than flacherie or muscardine. After having sought in vain the cause of the trouble, one forgets it until a similar accident happens.

"Chance taught me one of the unknown causes of this mortality. For several years I have reared different caterpillars in colored boxes for the purpose of determining the influences of refrangibility upon lepidoptera. The blue being, among the simple colors, the one that favored best their development, I had placed some pupæ of *Vanessa prorsa* in a blue box. There were already in this box some half-grown caterpillars of *Fidonia atomaria*, but they were in a tube and the tube had a cork stopper. A *Vanessa prorsa* emerged, expanded itself, and, ready to take to flight, discharged the meconium which it had accumulated during the pupal state. This meconium fell upon the stopper of the tube and immediately the twenty caterpillars were dead. It was difficult to ascribe such a power to the meconium. A second *Vanessa* again furnishing this liquid, I took some of it on a brush, and put it in another box where there were some caterpillars of no value to me. In a short time they likewise died, but other caterpillars touched with dry meconium lived as usual.

"It seems, then, that it is the vapor of this substance, composed mostly of uric acid, that has the property of killing caterpillars, and that when we rear caterpillars in the same vessel in which chrysalids are already formed, we subject ourselves to the same accident without suspecting the true cause."—*G. Dimmock, in Psyche.*

A GLASS OF WATER.

By A. L. KEAN and E. O. JORDAN.

WHEN one drinks a glass of ordinary city water, he often drinks not only H_2O, but also a multitude of living organisms. These are interesting from a purely scientific point of view, and have also much practical sanitary significance. Now that it has been found that a number of acute infectious diseases, such as typhoid fever, cholera, etc., are caused by certain tiny plants called bacteria, we can appreciate more fully than ever the dangers of an impure water supply. If, for example, the germs of typhoid fever find their way in any numbers into the water supply of a great city, it is not pleasant to contemplate the possible result. There is little doubt, however, that the danger is sometimes overestimated. When the new methods for the biological examination of water first came into use, it was thought that water containing any considerable number of bacteria was unfit for drinking purposes. As we gradually came into a more intimate knowledge of the subject, however, it was seen that there are many forms of harmless "water bacteria" capable of growing and multiplying even in distilled water. These innocent and probably useful forms may be present in water in comparatively large numbers without serious damage to health. Yet, for the sake of putting some sort of limit to the number of bacteria a good drinking water should contain, it is generally considered that any water that contains more than fifty to one hundred bacteria in a cubic centimeter should not be used unless purified in some such way as by boiling or filtering. This number, at the best, is an arbitrary standard, and in some good drinking waters is frequently exceeded. The limit given is based on general ideas of safety rather than on any accurate and precise knowledge.

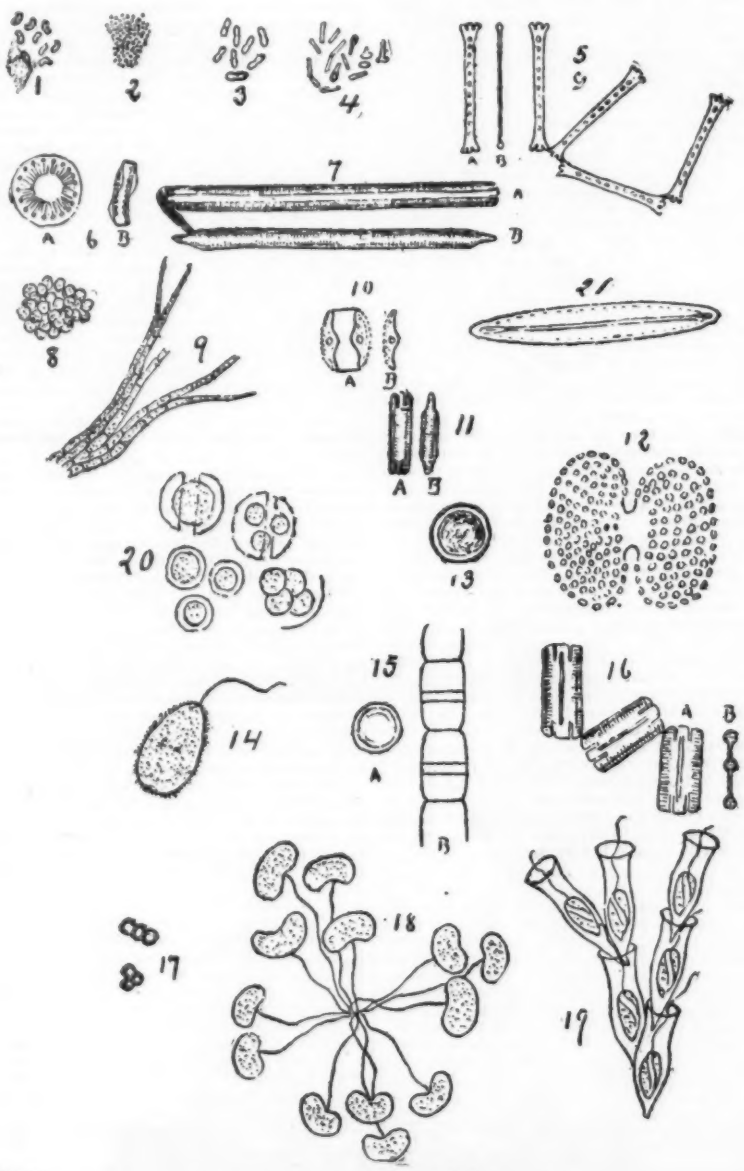
The present examination of Cochituate water was carried on along two separate lines—one, the usual bacteriological examination, and the other a microscopical examination of the algæ, etc., by a new method lately devised by one of us. The samples of water were taken in an ordinary glass holding a little over two hundred cubic centimeters. The glass was carefully cleansed, and before each sampling was rinsed three times with the tap water. It was then filled to the top of the 200 c. c. mark, and the bacteriological sample, consisting of one cubic centimeter, removed and planted. In every case the sample was planted within five minutes from the time of collection, in order to preclude all possibility of increase by standing. The remainder of the water was used for the microscopical examination.

The method used in making the microscopical examination was as follows: The glass of water, from which the bacteriological sample had previously been taken, was poured into a funnel, in the end of which was a half inch of fine sand, held in place by a plug of wire gauze, thus allowing the water free passage while holding the sand in place. Through this sand the water quickly filters, the microscopic organisms being detained by the sand. The bacteria, however, pass through with the water. The plug of wire gauze is then removed, and the sand washed down into a watch glass with one cubic centimeter of the filtered water directed from a pipette. The heavy sand sinks to the bottom of the watch glass, all the grains falling apart and setting free the light micro-organisms which remain suspended in the water. By this process all the organisms contained in the glass of water are collected into the one cubic centimeter in the watch glass. The object of this is to make the water so charged with organisms that it can be examined under the microscope; for, since only a very small quantity of water can ever be examined at once, it is rarely practicable to subject waters of comparative purity to a direct examination, because a number of examinations might be made without finding anything at all. The wash water containing the organisms is then examined under the microscope. The unit of bulk used is a cubic millimeter, and a sample of the water is placed in a chamber of that capacity. All the organisms in this chamber are counted, and by multiplying the count by 1,000 the approximate total number contained in the glass of water is obtained. The numbers obtained at first sight seem enormous, but when the minute size of the organisms is considered, it is easily seen that they must form a very small per cent. of the bulk of the water in which they are contained. It is, of course, very necessary to make several control counts and to strike the average of the different samples.

So far as is known, the common forms of algæ are in themselves perfectly harmless, but, unfortunately, wherever they live there also they die. Their bodies thus supplied to the bacteria enable these latter to thrive and multiply, and if a few harmful bacteria happen to be present in the water, they are given the chance to increase their numbers to what may be a dangerous extent. The inter-relations existing between the bacteria and the other microscopic organisms are at present very obscure. From the figures obtained from the samples, it is impossible to deduce any definite relation between them.

It must not be supposed for an instant that all the forms figured were found in a single glass of Cochituate water, or, on the other hand, that they represent all the species ever found in that water. They are simply figures of the different species actually observed in the ten samples taken. Of those figured, Asterionella (5) and Melosira (15) are the most common; after these come Chlorococcus (8) and Tabellaria (16). The others appeared only occasionally, though it would be unfair to say that they are uncommon, since they are all known to occur frequently in drinking water.

The method employed in the bacteriological examination was the method of gelatin plate culture devised by Koch in 1881. One cubic centimeter of the water is thoroughly mixed with a larger amount of melted nutrient gelatin, and the whole poured out on a glass plate. Each living germ that is originally present in the water forms a little group or colony about itself in the stiffened gelatin, and in the course of two or three days these colonies are counted and examined. All pipettes, plates, and other apparatus used are carefully sterilized by heating to 165°–195° C. for an hour. The gelatin is sterilized by heating in a steam bath for twenty minutes at a time on several successive days.



1, 2, 3, 4. Bacteria.
5. Asterionella. A, front view; B, side view; C, a colony.
Color, greenish yellow, with numerous vacuoles.
6. Cyclotella. A, front view; B, side view.
Color, greenish yellow; the diatomin which gives the color is contained in numerous round globules.
7. Synedra. A, front view; B, side view.
Color, greenish yellow; the color being confined to the edges.
8. Chlorococcus.
Color, dull green, varying to a brilliant green.
9. Calothrix.
Color, pale green, with numerous very prominent black dots.
10. Amphora. A, front view; B, side view.
Color, greenish yellow, much darkened along the edges by the external markings.
11. Fragillaria. A, front view; B, side view.
Color, greenish yellow, evenly distributed.
12. Closterium.
Colorless.
13. Trachelomonas.
Color, dark brown.
14. Chaetoglena.
Color, transparent green.
15. Melosira.
Color, green.
16. Tabellaria. A, a colony, front view; B, side view.
Color, greenish yellow.
17. Anabœna.
Color, blue-green.
18. Pleurococcus.
The bodies are clear green, while the connecting filaments are transparent and colorless.
19. Dinobryon.
The cups in which the organisms are contained are transparent and colorless, while the organisms themselves are a bright green.
20. Protococcus.
Color, bright green; the containing wall being transparent and colorless.
21. Pleurococcus.
Color, greenish yellow, contained entirely in the center along the mid-line.

The number of different species found in a sample varied from four to nine. The species were mainly common kinds, the very common "green water bacillus" greatly outnumbering any other kind in every sample examined. Other species found in several samples were (1) the Proteus of Hauser, which is frequently found in water and is generally present in putrefying matter everywhere; (2) a short, plump, oval bacillus, probably not yet described, which liquefies gelatin rapidly, and produces a very fine yellowish white growth on potato; (3) a bacillus that liquefies gelatin and sends out small migrating colonies which give a peculiar "spatter" appearance to the plate. These and the green water bacillus are all probably perfectly harmless, at least in small quantities. When, however, we take into our bodies even these comparatively innocent forms in so large numbers as indicated by the sample of Jan. 18—550,000 in a glass of water—it really becomes a question whether or not these apparently harmless bacteria may not be responsible (for an occasional "cold" or other slight ailment. Force of numbers may accomplish what a few thousand bacteria could not effect. This is something, however, about which nothing definite is actually known. The average sample of Cochituate water for the month of January, 1889, is certainly nothing to be alarmed at.

Date.	Hour.	Algæ in 1 c. c.	Bacteria in 1 c. c.	Mean Daily Temperature.	Rainfall.
	P. M.				
Jan. 15	12.30	50	63	27·5	0·00
" 17	12.30	100	69	54·5	0·35
" 18	12.30	315	2,798	37	0·00
" 19	5.30	305	1,134	....	...
" 21	12.30	270	114	34	0·38
" 22	1.45	200	78	23·5	0·00
" 23	1.00	315	65	28	0·00
" 24	3.00	175	73	40·5	Tr.
" 25	12.45	585	68	37	Tr.
" 26	2.16	130	89	....	....

Average in 1 c. c., 245 algæ, 454 bacteria.
Average in 200 c. c., 49,000 algæ, 90,800 bacteria.

If we throw out the unusually high numbers of bacteria found on the 18th and 19th, the average is 80, instead of 454. The high numbers for those dates are probably due to the heavy rain storm and high temperature of the 17th, but for the present this is merely a conjecture.

A glass of Cochituate water, then, from a Boylston Street tap, from Jan. 15 to Jan 26, 1889, contained on an average 49,000 algæ and 90,800 bacteria.—*Technology Quarterly.*

AN ESKIMO STRIKE-A-LIGHT FROM CAPE BATHURST.

By WALTER HOUGH.

THE natives of the Straits of Magellan and the Eskimo of Cape Bathurst are among the very few races that procure fire by means of flint, pyrites, and tinder. The use of the fire drill is almost universal; it is so with the flint and steel; but rare are the instances of the more primitive invention, the pyrites or fire stone, instead of the steel.

Capt. E. P. Herendeen collected at Cape Bathurst, north latitude 70° 40′, longitude 127° 30′, a very rarely visited locality and the limits of the western Eskimo, a nice lot of fur clothing. In the consignment was an Eskimo fire bag, that is, a pouch containing the implements necessary to get a spark to light a pipe or a fire. The essential parts are a piece of pyrites, a piece of flint, and tinder. The latter is made of the seed down of an Arctic plant, or frequently of willow catkins. It

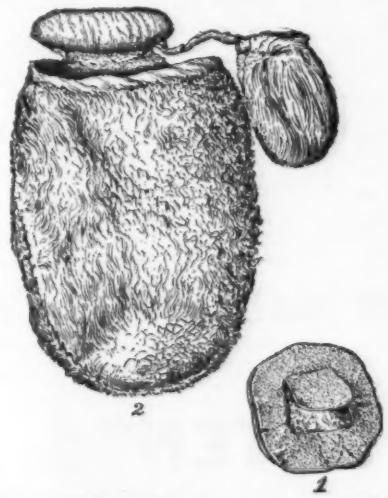


FIG. 1.—TINDER POCKET. FIG. 2.—FIRE BAG.

is prepared by carefully picking it and then soaking it in a strong solution of gunpowder in water to make it "quick," though this procedure is an innovation. The natives on the Putnam or Kuwuk River, in the region explored lately by Lieut. George M. Stoney, United States Navy, mix powdered charcoal with their willow catkin tinder, as do the natives at Point Barrow.* It is then put into a little, round, flat pouch, with a flap in the middle of one side (Fig. 1). The pyrites (Fig. 3) looks like a short pestle, into which shape it has been worn by the repeated scrapings it has received. The upper end has a natural concavity, while the lower end is as smooth as though it had been used for trituration.

The flint (Fig. 4) is an oblong piece, square at one end and rounded at the other. It is well chipped, and was evidently made for this purpose, though away from its surroundings as used it would be provisionally classed as a scraper, though not a skin scraper blade, as it is chipped on both sides. Dr. J. Simpson, in the Arctic Blue Book, says that flints are brought from the Kuwuk River. Mr. Murdoch tells me that the Eskimo think that pyrites comes down from heaven in meteors, and for this reason they call it fire stone. Two pieces of the latter are often used for striking fire. A native told Mr. Murdoch that in old times they did not use flint, but two pieces of pyrites, and got "big fire." The pieces of flint used at Point Barrow are small and are not fixed in a handle. The flint under consideration is mounted in a short wooden handle (Fig. 4*a*), of two pieces, rudely dressed down with a flint tool, as

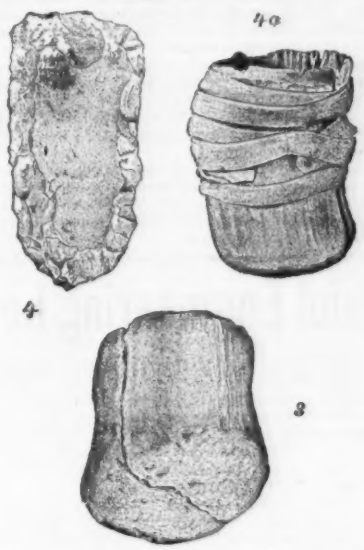


FIG. 3.—PYRITES. FIG. 4, 4*a*.—FLINT STRIKER AND HANDLE.

may be seen from the character of the cutting, which is striated, as though done with a serrated edge. This is corroborative evidence to that of Capt. Herendeen, who says that this is a genuine relic of the times before the use of the steel was known to the natives, which has not been long on the extreme Arctic coast whence this specimen comes. The bag (Fig. 2) is made of the scrotum of the reindeer. The little bag which hangs attached to the larger has a double use: it is a receptacle for tinder, but its chief use is as a toggle; being passed under the belt, it prevents the loss of the outfit, which is carried by the women.

An oblong pad stuffed with deer hair is sewed to the mouth of the fire bag to protect the hand from sparks and blows of the flint.

To get a spark, the Eskimo places the piece of pyrites on the pad held in the left hand over the curved forefinger (Fig. 5); it is placed large end down, and the thumb set in the cup cavity in the top. The flap of the tinder pocket is turned back and held on the forefinger under the protecting pad. The flint is held in the right hand, and by a scraping motion little pieces of pyrites at a dull red heat fall down into the tinder. The pellet that glows is transferred to the pipe of fire, and the flap of the tinder pocket is turned down, serving to keep the tinder dry, and to extinguish it if necessary.

It is a rare and complete fire-making set, and in the minutiæ and number of accessories shows true Eskimo elaboration, though in detail rudely made. Professor Mason remarks on Eskimo ingenuity that the Australians and Puru-Puru were satisfied with the simplest form of throwing stick, while the Eskimo have invented a dozen different species with numerous co-ordinating attachments on the spear.* This is also a good ex-

FIG. 5.—USING THE STRIKE-A-LIGHT.

ample of independence of invention by the Fuegians and the hyperboreans. The former could use no other means; in that supersaturated atmosphere it is impossible to get a spark by means of a drill.† At Cape Bathurst the cause of the abandonment of the fire drill was the extreme difficulty and tediousness of getting fire in that way. The museum is in possession of a specimen of flint and pyrites from Fort Simpson, a station on the Upper Mackenzie River. It was collected from the Indians by R. B. Ross many years ago.‡ Another outfit, consisting of a bag with pyrites and bark tinder, was collected in Alaska by John J. McLean, and is presumably Indian.* It is possible that these throw some light on the Indian origin of some of the Eskimo arts, a matter not unlikely to happen, as it is of common observation that the Eskimo is adaptive, and it is quite to be expected that there would be reciprocal borrowing of useful arts by the neighboring tribes.

The cigar lighter (Fig. 6), called a strike-a-light, purchased in Paris by Mr. Thomas Wilson, is introduced here to show the survival of a primitive custom. The inhabitant of the Avenue de l'Opera, in the "capital of civilization," and he of the shores of the frozen ocean touch. One of the chief qualities of civilization is its adaptiveness, and there is no device of savage man

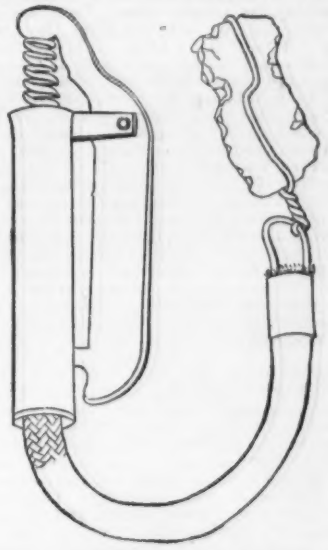


FIG. 6.—FRENCH STRIKE-A-LIGHT.

which civilized man cannot appropriate and mould to his own use; but the remains of old usages and arts stick to him and come down, if not in ethnical sequence yet in direct course, from the man acquainted with the use and properties of flint, for instance, in the valley of the Somme.—*Proceedings U. S. Nat. Museum.*

THE PAMPAS PLUME INDUSTRY.

By JOSEPH SEXTON, Santa Barbara.

THE growing of pampas plumes for profit is an industry of quite recent introduction, and as yet but little is known of it. The pampas grass (Gynerium argenteum) is a native of the pampas plains of South America, and was introduced into the United States about 1848. It is not sufficiently hardy to stand the rigor of Northern winters, but is in the cold parts of this country frequently planted on the lawn in summer, and upon the approach of cold weather is transplanted into a tub, and carried into the cellar. In California it is perfectly hardy, and a hill will sometimes attain a height of 20 feet, a diameter as great, and a weight of 2,000 pounds. These would be quite inconvenient for our Northern friends to handle in the cellar. The plants are easily produced from seed, but as the sex and variety are very uncertain, they are usually multiplied by dividing the female plants, the plumes of which are much more beautiful than those of the male.

For many years the pampas grass was grown only for ornament, but in 1874 the difference in sex was discovered, and since that time the industry has gradually increased.

In 1872 I planted seed; in two years several hundred of the plants produced plumes. Many of these were sold when small plants to persons purchasing them purely for ornamental purposes, but the variations in shades and fineness were very marked.

In 1874 the discovery was made that by pulling the immature plumes from the sheaths and exposing them to the hot sun the male plumes would hang heavily like oats, while the female would fluff up and become light and airy.

We saved a quantity of the female plumes, some of which were sold in Santa Barbara, while others were sent to San Francisco in November, 1874. Samples were also sent to Peter Henderson & Co., of New York. Three hundred were ordered at once, and the following day instructions were received to double the order and send by express. This was the first lot of good plumes ever sent east from California, and was the beginning of the present pampas industry. My plantation has been extended to 5,000 hills, and there are a number of other quite extensive plantings in the neighborhood of Santa Barbara. The plumes shipped from Santa Barbara have the reputation of being and are undoubtedly the finest sent to market. The crop this year is estimated at 1,000,000 plumes. The demand for the two last years has been good, but the prices have never been so high as they were at the beginning of the industry, $200 per 1,000 plumes. The decrease in price was gradual until 1886, when sales were slow at $30 per 1,000. Some of the growers did not harvest their crops that year, and destroyed their plants. In the fall of 1887 plumes were in demand at $40 per 1,000, and in 1888 they were scarce at $50 and $60 per 1,000. So this winter there will be a large increase in acreage.

Pampas grass plants should be put on the best valley land, at a distance of 10×16 feet apart. Some are planted closer, 8×10 and 10×10; but if they are to become old plants, it is better to give plenty of room. Before planting, the land should be plowed deep and put in first class order. In selecting stock, divide only female plants that produce the finest white plumes.

Young hills produce the best plants. From old hills the best plants are obtained around the outside, those in the center of the stool being mostly worthless unless planted in large clumps. They will produce some plumes the first year, not first size, but worth saving.

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* Report of the Expedition to Point Barrow, Alaska, Lieut. P. H. Ray, U. S. Army, p. 46.

* "Resemblances in Arts Widely Separated." "American Naturalist," Mar. 1886, p. 251.

† Peschel, "The Races of Men," p. 148, cites W. P. Snow's "Off Tierra del Fuego," II., p. 350.

‡ No. 1,861. Fire-making outfit. Fort Simpson, British America, R. B. Ross.

* No. 60,222. Fire-making outfit, Alaska, J. J. McLean.

The second year they ought to produce from 80 to 150 plumes to the hill, if well grown, though not all plantations will do this well. The third year the crop will be about the same. From that on the plumes decrease in number, but are larger and finer. At this stage the plants can be improved by trimming or burning away the dead portions. When the plumes commence to make their appearance, it is a signal for great activity among those who have large fields, and everything is put into shape, so that there will be no hindrances.

The grass should be so trimmed early in September, before the plumes appear, that each hill may be easy of access. Young plants produce two to three weeks earlier than old ones, and some varieties are earlier than others It requires exercise of judgment to pick the plumes at the proper time. They are generally ready when they are exposed from the husk a few inches, and have a fluffy look. It is well to try a few at this stage, and if they cure well at the stem end when dry, they are all right, but if they do not fluff up at the stem end, they have been picked too young. If the plume looks dark and seedy at the top when cured, it was too old when picked. Some varieties, especially those producing very long plumes, should be allowed to remain somewhat longer on the plant than the plumes of the short producing varieties. By trying a few of each variety that may be in your planting, the time of ripening can soon be ascertained. As the plumes are cut in the field, they are taken to the husking bench, to have the husk or sheath removed. This is done in several ways; some pull them out, but if this is not cleverly done, much injury results. The best way is to set a knife sufficiently high to split the husk, but not injure the plume; when the husk has been split, a quick jerk or strike on the table will extract the plume.

From here the plumes are carried to the drying ground, and evenly spread in long rows. This ground should be made smooth and free from any trash liable to adhere to the drying crop. It takes three days and two nights for the plumes to cure, and they should be shaken and turned once each day while curing. They are next packed away as broad and smooth as possible on wide shelves, in airy buildings. They should lie there from ten days to two weeks, or until the stems are thoroughly dried, at which time they are ready for market. In preparing for shipment, one, two, or three grades should be made, according to the market to which they go. If shipped by express, they should be packed in bales of say 2,000 plumes. A covering of canvas or burlap, and some light strips of wood at the corners, will complete the package. If shipping is done by freight, it does not make much difference as to the size of the boxes used, provided they are not less than four feet long. A good size box is one four feet long, two feet two inches wide, and three feet two inches deep. A box of this size will hold about 3,000 first class plumes. If packed smooth and straight, there is no danger from tight packing, and very heavy weights can be used. They can be easily restored to their original beauty by exposure to heat and a gentle shaking. The largest demand for the last few years has been from England and Germany.

The pampas plume is used exclusively for decorative purposes, and when used on a large scale, makes a grand display. Many are used in the making of dried grass bouquets, etc. Pretty dried grass holiday cards, in which the pampas is the chief ingredient, are made in Germany, and sent to California to be sold as souvenirs.—*Cal. Florist.*

RESORCIN IN WHOOPING COUGH.*

IT would be an unnecessary task to refer to all the treatments advised; it will answer my purpose merely to relate the course I follow. Weary of employing against this disease all the measures which I saw recommended abroad, I decided to follow that used by Dr. Moncorvo, of Rio Janeiro, and I did practice pencilings in the larynx and pharynx with a solution of resorcin (one per cent.), which he recommended, but I did not obtain quite as good results as he indicates. I liked the drug on account of its antiseptic properties and its taste, which rendered it easy to administer to children. In spite of the first failures, I continued its use, increasing the dose gradually until I observed that with a strength of four per cent. the attacks became less frequent, and the whooping cough was cured within three or four weeks.

Encouraged by this success, and observing carefully my patients and testing their urine, I saw that I could increase the dose of resorcin without danger. Nowadays I use a ten per cent. solution of resorcin for penciling the pharynx and larynx. This proportion need frighten no one, for children stand it very well. I generally use the following formula:

Resorcin (chemically pure).....	2 grammes.
Ethylic alcohol	5 "
Pure glycerine.	15 "

Mix. Pencil every three hours.

This quantity will last two days, which will correspond to one gramme a day. When it excites cough easily, I substitute ten grammes of sirup of acacia for the five of alcohol. If at the beginning there should be intolerance to the gentle friction of the brush, I usually apply cocaine (3% per 100) before using the resorcin.

In order to prevent drying of the throat during the night, I maintain in the bed room a temperate moist atmosphere, by the continuous evaporation of a certain quantity of water, and during the day the room and the bedding are thoroughly aired. With this treatment I have succeeded in quieting the cough in five or seven days, leaving a catarrhal, non-convulsive cough, which can be corrected with balsamics. Complications should be treated as they arise.

Since I have been using the ten per cent. solution of resorcin, I have had eleven cures in children, whose ages varied between seven months and five years, and in the space of time above mentioned. Since last March I have cured twenty-four children with this remedy.

An impure resorcin may give rise to violent attacks of cough. In commerce three varieties are found: First, medical resorcin, chemically pure, presents itself in the form of very fine needles of a brilliant white color and phosphorescent in the dark, and when exposed to the light shows no coloration, and is slightly aromatic; second, resorcin crystallized in prismatic needles, which become slightly rose-colored upon exposure to the air; third, commercial resorcin, an impure product, and dangerous to use on account of its inconstant action, appearing as crystals of a pomegranate color, and having an intense phenic color.

I have in my possession samples of resorcin from different sources which present the characteristics which I have just enumerated. The resorcin which I have used, and which always should be used, is the chemically pure.

Before resorting to the resorcin treatment, I tried quinine in small and frequent doses, and it is, I believe, next to resorcin, the most acceptable remedy; but it has the disadvantage of becoming intolerable to the little sufferers on account of its taste, and, moreover, it disturbs the digestive organs.

My conclusions are:

1. Whooping cough is a parasite and contagious disease.

2. It is a local disease. It is seated in the laryngeal mucous membrane, and may extend to surrounding structures.

3. The best treatment of whooping cough known to the present time is that based on the local application of a ten per cent. solution of resorcin.

4. The complications should be treated independently of the whooping cough.

* Trans. from Spanish by A. McS. Kane, in *N. O. Med. and Surg. Jour.*

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